Photo-Engraving

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Why ask for the moon
when we have the stars?

AS

1st English ed.
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THE GRAMMAR

OF

PHOTO-ENGRAVING.

By H. D. FARQUHAR.

WITH ADDITIONAL MATTER ON THE FISH GLUE ENAMEL PROCESS BY THE STAFF OF THE "PHOTOGRAM," AND A VALUABLE APPENDIX ON THE MAKING OF HALF-TONE NEGATIVES, TRANSLATED FROM THE GERMAN BY

Dr. J. M. EDER.

CONTAINING INSTRUCTION IN

DRAWING, CHEMISTRY AND OPTICS, AS APPLIED TO PHOTO-ENGRAVING,

AND A PRACTICAL TREATISE ON THE ART OF

Half-Tone, Zinc Etching, Swelled Gelatine, Lithotype and Chalk Plate Engraving, as Practiced in the United States.

ILLUSTRATED.

LONDON:
DAWBARN & WARD, Limited,
FARRINGDON AVENUE.

1895.

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PUBLISHERS' PREFACE.

THE frequent enquiries for this book, and the number sold in England in spite of its high price (8s. 4d. paper; 10s. 6d. cloth), caused us to believe that an English edition would be appreciated. After arranging with the proprietors of the copyright we found that the cost of producing the book entirely in England, in an edition such as can be anticipated for a technical work of this sort, would force us to place the price at 5s. or 6s., whereas, by printing from the American plates, we were able to reduce the price considerably, and, in the interests of our customers, prepared to do so.

The few American expressions used are explained by the context; for instance, the "thumb-tacks" mentioned more than once are obviously "drawing-pins." We give a list of errata, correcting such printer's errors as may possibly mislead; and append instructions for the fish-glue half-tone process, which has come into very general use since the book was written.

Should any beginner find difficulty in working the processes herein described, he will obtain much assistance from *The Process Photogram*, the Editors of which are prepared to answer any query that is accompanied by stamp for reply.

Yours faithfully,

THE PUBLISHERS.

ERRATA.

Page 39, line 9, for "iodide" *read* "iodine."

„ 48, „ 2, for "vaces" *read* "vices."

„ 51, „ 7, for "turned" *read* "named."

„ 73, „ 22, for "asphalt undissolved" *read* "asphaltum dissolved."

„ 85, „ 2, for "screens" *read* "screws."

„ 105, „ 20, for "edge" *read* "etch."

„ 124, „ 12-14. This plate was not included in the American edition, but similar plates are given with *The Photogram* of January, 1895.

PREFACE.

THE object of this book is to present to the constantly increasing number of persons seeking after practical knowledge in the art of process engraving, a comprehensive and thoroughly reliable text-book. The book has been written with a view to instruct the amateur as well as the professional, and the writer has always had in mind the beginner, counting no detail too trivial to be fully described.

It has been written for the most part in the leisure hours, after practical service during the day in a photo-engraving establishment, so that the instruction goes directly from the shop to the pupil. It has been the author's hope, in writing this book, to so carefully describe every branch of work connected with the subject, that the beginner, who knows absolutely nothing about it, may become a practical photo-engraver from a careful reading of the work.

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The Grammar of Photo-Engraving.

CHAPTER I.

DRAWINGS FOR PHOTOGRAPHIC REPRODUCTION. —THE MATERIALS REQUIRED.

The first requisite for the best results in photo-engraving is good "copy." As pen-and-ink drawings produce the best results, I will begin with a brief description of the tools and material used, and how to make drawings suitable for the photo-engraver.

Card-Board.

Card-board finely finished with a smooth, white surface is necessary. Bristol board, known as four-ply wedding, is the best. It holds its color, and does not fade or turn a dark, dirty color as some of the cheaper grades of card-boards do. Its surface is smooth, having a good color it takes ink well, and will admit of pencil lines being erased without making a rough surface. Scratch, or lithographic board is, for certain kinds of work, preferred to the Bristol board. The lines cannot be made so fine on this as on Bristol board, as the pen soon clogs up from the enamelled surface. Its only advantage is that it can be scratched with a knife point or lithographer's needle, making a finer line than can be produced with a pen and Chinese-white.

Where white lines are wanted with a black background it will also be found useful, by printing in solid with black drawing ink, using a camel's hair pencil brush, and, when perfectly dry, the design can be scratched through the ink and the coating on the card-board.

Ink.

Drawing ink, which will make the finest as well as the heaviest lines perfectly black, is difficult to procure. The

best quality of India ink is used by many. It is rubbed up in a saucer with clean water until it becomes the proper color, which can be ascertained by drawing very fine lines on the margin of the paper. If they are perfectly black, and not of a brownish color, it is all right. A few drops of a solution of prepared ox-gall added when rubbing up will cause the ink to flow freely from the pen. Only what is needed for each day's use should be made up at one time, as it soon becomes unfit for use.

The greatest disadvantage of this ink is that it is not water-proof, which fault makes it useless for drawing over silver prints, as it would wash away in the process of bleaching, leaving the lines a pale brown-color.

Indestructible drawing ink is now almost universally used for these drawings; it is waterproof and is not affected by acids or alkalies, and makes a perfectly black line without gloss.

Prepared Papers.

Ruled or stippled tint paper comes in sheets like card-board or paper. It is of various styles and gradations of lines, fine, coarse, or wavy, stippled ground and sky, circular, oval, or tubular tints.

These tints are prints made on plain or coated paper and card-board. Another style used for drawing with lithographers' crayon has the lines or stipples embossed.

The first is used mostly for pasting in tints. The tints from which you desire to produce the proper shading effect are selected. Then make a tracing of the outlines on tracing paper of that part of the drawing you want to shade; transfer it to the tint and cut to the shape desired; paste it on the card-board in its proper place with a good starch paste which will not turn yellow. The moisture from the paste will allow the tint paper to stretch enough, as it dries, to cover the lines of the sketch if you have cut it properly.

Each tint is added in this way until they are all in.

The tint, when mounted, will be higher than the drawing, and the edge will cast a shadow; when photographing, this will show a white line on the negative, and will not produce a

good engraving without a great amount of touching up on the cut with gravers. To prevent this the edges of the tints are lined with pen and ink where possible.

When dry, these tints may be drawn on and cross-hatched to produce any additional shading necessary.

Cuts of buildings, machinery, etc., can be well produced by this method, they will have the appearance of having been made on a ruling machine.

The stipple, or embossed paper, is used generally when lithographic effects are desired in one or more colors. For drawing on this paper lithographic crayon is used. The following is a recipe for making

A Suitable Crayon.

Pure white wax	4 ounces
Gum shellac	2 ounces
Dried soap (made of tallow and soda)	2 ounces
Oil copal varnish	1 ounce
Lampblack	1 ounce

The wax is melted over a slow fire; stir in by degrees the gum lac, broken into small pieces; next add the soap reduced to fine shavings; then stir in the copal varnish, into which the lampblack has been previously ground. Continue to heat and stir until the paste acquires the proper consistence, which can be ascertained by forming a pencil of it in a mould, and allowing it to cool. The mould should be first wiped with a greased rag.

The picture is made by rubbing the crayon over the surface of the paper similar to the way pencil drawings are made.

Tracing Paper.

Tracing paper should be the best that can be bought of dealers in artists' material, but a very good paper is prepared by dissolving

Beeswax	1 ounce
In turpentine	½ pint

This solution is applied to very fine white woven tissue paper, laying on a clean board, and with a soft brush dipped in

the liquid going over one side of it, then turn over and apply the liquid to the other side and hang up to dry in a place free from dust.

Gelatine Sheets.

Sheet gelatine is sometimes used for tracing where paper is not sufficiently transparent to show fine details. There are three grades in thickness, the thinnest being generally used.

Transfer Paper.

Carbon, or transfer paper, is used for placing under prints or sketches, and for tracing lines with a sharp point, to make an offset. It is prepared by rubbing on one side of unsized paper a pigment of the color desired. The following will be found good:

For red paper	Venetian red
For blue paper	Prussian blue
For green paper	Chrome green

Apply with a flannel rag and rub with a clean piece of paper until the color ceases to come off.

Drawing Pens.

Steel pens that make fine lines and move over the paper without scratching its surface are the best. Gillott's No. 290, 170, and 303 are the ones generally used.

Other tools that are useful and in fact necessary are drawing boards, squares, triangles, irregular curves, compasses, bow-pins, brushes, lead pencils and thumb tacks, dividers, scrapers, dotting pin, pantograph, sponge, rubber and beeswax.

Making the Drawing.

If the drawing you are to make is an original, the sketch is first made on an ordinary piece of sketch paper twice the size of the cut desired by making an outline of the subject, representing the most essential parts of the shading. A piece of card-board of proper size is selected and laid on the drawing board. On this, face down, put the transfer paper. Place

upon it the sketch face up, and fasten the two top corners to the drawing board with thumb tacks. Commence to trace over the lines of the sketch with a lithographer's tracing needle, occasionally inspecting the tracing by lifting up the lower corner. The pressure on the needle should only be enough to make a visible impression.

When the tracing is completed, remove the sketch and transfer paper, commence to lay in the drawing with pen and ink, making the lines as smooth as possible. The outlines should be entirely completed before the shading is attempted at all. The proper shading is most difficult to acquire. A good plan is to study the work of experts. Select what you think a good subject for practice and make a tracing of it; then make the drawing complete, following the copy line for line. In this way you will soon learn how wide apart the lines should be drawn to reproduce well.

Portraits, as a general thing, are the most difficult and require more study than a building or landscape. A very fine shading made in imitation of stippled steel engravings produces better color and looks softer than when made by lines. Artists who can do this style of portrait shading well are few, as it can only be successfully accomplished by adhering to that class of work only. There are, as a rule, not many who are experts in general work. The best generally adhere to the class of work they can do best. If you can make a better portrait than commercial or machine work, better make a specialty of that particular line and stick to it.

Tin-Types.

It sometimes happens that a drawing has to be made from a photograph larger than the copy. In this case have a ferrotype (tin-type) made the size the drawing is to be; from this make a tracing and then transfer to the card-board.

Silver Prints.

A silver print is preferred by some to the ferrotype. It is made by taking a print from a negative the proper size on plain salted Rives or Saxe paper.

Float the paper on a silver solution composed of

Water	20 ounces
Nitrate of silver	1¼ ounces

The paper is allowed to remain upon this solution one minute, when it is removed, care being taken not to allow the solution to get on the back of the paper, or air bubbles to get underneath it. It is best to drag it from the solution over a glass rod placed at the end of the tray. It is then hung up to dry in the dark-room.

When dry, place your negative in a printing frame the same as used by photographers; on this place the sensitized paper to expose to light. It generally takes from five to ten minutes to complete the exposure in the sun. The progress of the print can be seen by unfastening one end of the printing frame and lifting up the paper. When it becomes a dark-brown color, and the details can be easily seen, remove from the frame, place in a tray and allow water to flow over it for about ten minutes. This dissolves the unchanged silver and washes it away. It is now placed in the fixing bath which is composed of

Hyposulphite of soda	2 ounces
Water	10 ounces

The picture assumes a pale appearance when placed in this bath, and should remain therein until the whites become clear and free from color. The time required is from five to ten minutes.

This bath leaves considerable hyposulphite of soda in the paper. If allowed to remain decomposition would soon take place. The sulphur combines with the silver forming sulphide of silver which turns yellow. It is therefore necessary to thoroughly wash the picture by letting it remain in running water for at least one hour.

The print is then removed from the water, and partially dried between pieces of blotting paper, when it is pasted on a heavy piece of card-board and allowed to dry.

The artist now takes it and draws the outlines and the principal features with ink. It is advisable not to try to put

in much shading as the picture is likely to mislead you. Better copy from the original. When you have drawn the necessary lines, and the ink has become thoroughly dry, the print is bleached away, leaving the lines made in ink on the print. This bleaching bath is composed of a saturated solution of bichloride of mercury in alcohol.

Water, or equal parts alcohol and water, may be used in place of pure alcohol in preparing this solution, but it is not so good, as it takes longer for the paper to dry, and the sharp lines are liable to blur.

When the last trace of silver deposit has left the print, remove and wash well in alcohol. When dry the drawing may be completed.

There is an objection to making drawings over these prints, and that is, they will not keep their white color for any length of time. It is advisable to keep them from light as much as possible. The fixing solution of hyposulphite of soda should be fresh in all instances. An old hypo bath is liable to stain the print yellow.

Gelatine and Celluloid.

A quick and accurate method of making drawings for ordinary work from photographs is to take sheet gelatine or celluloid that is clear and transparent as glass, place over the copy, and fasten to the drawing board with thumb tacks. Proceed to make a drawing with pen and ink on the gelatine, tracing the outlines of the picture exactly the same as when drawing on card-board. The lines cannot be made as fine as on paper, but with practice and the use of but very little ink surprising results may be produced.

When photographing from these drawings tack a piece of white card-board to the copy-holder; on this place the drawing. It will be seen that this makes a suitable copy, and for the cheaper grades of work is unrivalled for quickness.

Benzine Paper

Another method similar to the above is as follows:

Take flat cap paper with a smooth white surface. This is

placed over the photograph, as described in the foregoing methods, and by gently rubbing over its surface with a rag moistened with benzole it immediately makes the paper transparent, revealing the finest details in the dark shadows of the photograph. A drawing is now made with a lead pencil or pen and ink, applying more benzole as it evaporates. The benzole does not at all interfere with drawing either with pencil, pen and ink, or water colors.

When the drawing is completed the paper is allowed to dry, when it resumes its original opacity.

Transfer Paper.

In drawing on transfer paper more precautions are necessary than when card-board is used. It should not be touched with the fingers, as each mark will appear when transferred.

A good transfer paper is made as follows: Lay the paper in three successive coats of sheep-foot jelly, one layer of cold white starch, and one layer of gamboge. The first layer is applied with a sponge dipped in a hot solution of the jelly, thinly, but very evenly, over the whole surface. The next two coats are laid on in succession, each previous coat being allowed to dry. The layer of starch and then the gamboge are each applied with a sponge, the same as the jelly. When the paper is dry smooth it by passing through a lithographic hand press. If you have no press, a heavy sad-iron slightly warmed will do. Lay the paper face down on a glass plate, which must be perfectly clean, and rub over the paper with moderate pressure.

In preparing the above always dissolve and use same day, as it becomes oily by standing. The starch should be about a day old; remove the skin that forms on its surface.

A special ink is also used for drawing on this paper. The ordinary drawing ink will not do as it will not transfer. What is known as lithographic tusche or autographic ink is used. It is made of

White wax	8 ounces
White soap	2½ ounces

Melt; when well mixed add

Lampblack..... 1 ounce

Mix well and heat it strongly and add

Gum shellac (orange)..... 2 ounces

Mix, again heat strongly, stir well, allow to cool a little and pour out, and when set, form into cakes about the same shape as India ink.

It is prepared for use by rubbing down with a little water in a saucer, the same way as India ink. In winter this should be done near a fire, or the saucer should be placed in warm water.

With this ink lines may be drawn of the finest to the fullest intensity without danger of its spreading, and the copy may be kept for years before being transferred.

The drawing is made by making as few pencil lines as possible in the sketch. These lines do not transfer so it is not necessary to remove them.

Use a pen as fine as will mark on the paper without its catching. If necessary to make corrections a knife or scraper should be used, being very careful not to scratch deeper than just enough to remove the ink. Then take a little of the starch paste used in the preparation of the paper and apply with a camel's hair pencil; when dry it can be drawn over. Corrections can generally be made better on the zinc after the transfer has been made.

The method of transferring from the above will be described under its proper heading.

Grained Zinc.

Zinc with a suitable grain for drawing on can now be purchased. There are three grades of it and of any gauge of thickness. The drawing is done the same as on grained or stipple paper, using the same crayon to draw with. The solid blacks are painted in with crayon dissolved in turpentine made to the thickness of cream. Apply with a camel's hair brush. When the drawing is completed it is ready to be etched.

Polished Zinc.

Drawings are made on well-polished zinc, using the same precautions and manner of working as on transfer paper; the same ink also being used.

Corrections are made on polished and grained zinc with charcoal. The kind used by artists comes in thin sticks about the size of a lead pencil, it is the best. Sharpen to a point and rub over the place to be corrected until all ink is removed, care being taken to get off all grease.

Drawing in General.

In executing drawings with pen and ink for photo-engravers, the beginner experiences the greatest trouble in determining how far apart the lines should be drawn to get the best effect.

Drawings are always made larger than the cut is to be when completed. For the finest work the reduction being made to one-quarter the size of the drawing. The general run of work, however, is made for a one-half reduction.

This method allows the artist more room to work in. The reduction makes the lines finer and covers up defects that would be objectionable were they large enough to be noticed.

The proper amount of space to allow between the lines depends entirely upon the subject and the amount of color you want to give. This can only be determined by continued practice and study of drawings from experienced workmen.

When making drawings which are to be shaded the outlines must be first put in. The proper degree of shade should be produced at one operation without having occasion to go over or darken it afterwards. Retouching spoils the effect of clearness and spirit which shading is intended to give. Lines should not be cross-hatched or gone over the second time until perfectly dry.

In shading the nearer parts should be made darker than those distant; this causes the latter to recede, giving it the appearance of distance.

To shade parts in the foreground brings forward the lights; this effect is called relief. It is very important that the

beginner should clearly understand the method of producing this effect.

Try the experiment of placing objects so as to relieve each other, and sketch them in this position.

Perspective.

The word perspective expresses the appearance of an object when viewed from any given point or station, and the art of making such a representation of an object upon a plain surface as shall present precisely the same appearance that the object itself would present to the eye situated at a particular point.

Aerial perspective is the art of giving due diminution to the strength of light, shade and colors of objects, according to their distances and the quantity of light falling on them. Geometry teaches us how to describe squares, circles, and various other regular and irregular figures, but these instructions refer exclusively to their geometrical representation, as they would appear on a plane surface at right angles with the line of vision—that is, placed directly opposite to the eye. If they be not exactly opposite to the eye they will assume different appearances.

In a view embracing a number of objects only one of them can be situated exactly opposite the eye, the remainder will be viewed more or less at an angle according to their respective positions. Therefore only one of those objects, if truly represented, as they appear, will present a geometrical outline; the others will all have perspective outlines presenting two or more of their sides to view at the same time.

If by placing a book in the various positions, as shown in the illustration, a series of correct perspective representations will be shown:

Holding the book level, as shown in Fig. 1, nothing will be seen but a geometrical view of that edge. Figures 2 and 3 show these sides in different positions of perspective. When looking at these figures, the sides of which are of equal length, we will find that they appear to the eye of different lengths. The surface opposite our eyes appears geometrical as the end of the book in figure 3, the others become shortened in a remark-

able manner. The surfaces appear quite irregular; the parallel lines converge at the point 4. If we stand at the end of a long, straight street and look along it, the line of the buildings appear to draw nearer to each other as they recede from the observer. If the street is long enough they will

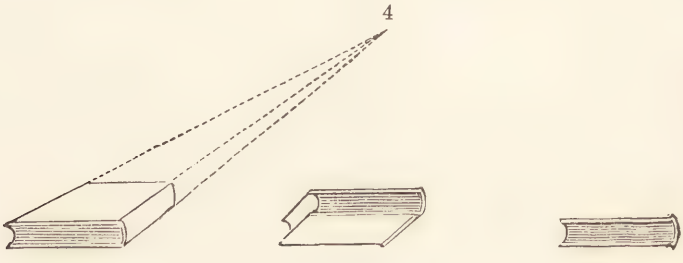


FIG. 3 FIG. 2 FIG. 1

approach each other so near as almost to meet at a point. By following the line on the opposite side of the street you will perceive a still greater inclination, all apparently running toward the same point.

It will also be noticed that the tops of the buildings manifest the same tendency to approach each other and meet at some point at the end of the street. The lines on or near the ground point rather upwards, those being about as high as the head are level while those above the head, as the cornices and upper windows, incline downward. The higher the latter are, the greater is their slope downward. The same effect may be seen in any room or long hall. Stand at the end of the apartment and observe the direction of the lines of the ceiling and walls. It will be found that the lines appear to converge toward an unknown point in reality parallel and horizontal.

Since flat or plane surfaces are bounded by lines, it follows that changes in the direction of such lines cause corresponding changes in the form of planes which they inclose. The ceiling and floor of a room are planes whose appearance are determined by the lines at which they meet each other. Solids are next in order after lines and planes. Planes are denoted by lines representing their external form, likewise solids are de-

noted by the planes representing the forms of their various sides. Any object composed of straight lines is termed a solid body whose external form is an arrangement of various planes. The true perspective representation of such a solid body will be composed of perspective views of such of these planes as can be seen at once from any given point. As the perspective appearance of planes is changed by a different position in the direction of the boundary lines, so is that of solids changed by changes in the outlines of their constituent planes. Having shown that lines and planes change their appearance according to the position from which they are viewed, it follows that the *point of view* has a corresponding effect on the outlines and appearance of solids.

Next it will be necessary to make rules by which the exact appearance of lines, planes and solids from any given point of view may be drawn on paper.

First ascertain the exact points toward which the lines of such objects converge, and at what point they would meet if produced. These imaginary points are called vanishing points; if a plane were long enough to reach as far as the sight, its top and bottom lines would meet at such a point, and the plane would seem to terminate or vanish at that point.

These points are of much importance in perspective, the principal one of them being the point of sight, which is the point that is exactly opposite the eye of the observer, and is always near the line of the horizon.

The height of the horizontal line depends entirely upon the height from which the observer is to stand, the horizontal line being opposite the eye.

It is then evident that the line of the horizon is always on a level with the eye of the artist.

When standing on level ground the horizon will appear low as in Fig. 5.

If from a higher point the horizon will be higher, as Fig. 6. From a still higher point, as in Fig. 7, the field of vision is extended further.

As is seen by the above illustrations the horizon is located at the height of the eye. It follows that the ground will

ascend more and more as we raise the horizon. The artist's position is termed the stand-point when drawing perspective.

When looking through a window, if we were to trace on the surface of the glass the lines of the objects seen it would make



FIG. 5



FIG. 6



FIG. 7

a true perspective drawing of those objects. Suppose that a pane of glass is placed in front of the eye vertical to its axis. The rays which proceed from an object *A*, *B*, *C*, *D*, will

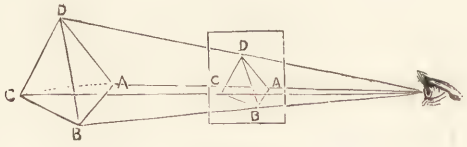


FIG. 8

intersect the glass in the figure *a*, *b*, *c*, *d*, (Fig. 8). When such a figure is constructed for a given point of intersection and a given plane, then the drawing, when it is brought to the correct position and distance in front of the eye, will give exactly such an image as the objects themselves appear. This explains the deception that a correctly constructed plane picture appears in relief.

The plane of a picture is imaginary, supposed to exist somewhere between the artist's eye and the object, the picture itself being a copy of the view that would be seen through such a plane.

An angle of 60 deg. is the largest that should ever be chosen in fixing the position of the eye with reference to any object

to be drawn, especially when many objects are included in the drawing.

In the foregoing perspective drawing has been only briefly described, but it is sufficient to give the beginner an idea of its importance to make drawings appear correct when laid down on paper. It is hoped that before attempting to do work for the trade that the above will induce the reading of a good work on perspective.

The author has seen drawings made by tracings from a photograph that were so far out of perspective as to be unrecognizable. For commercial work very little knowledge of perspective is required, but with a clear understanding of it better work can be done.

Shading.

To make a true representation of objects by drawing, it is necessary to introduce light and shade. In newspaper illustrations very little shading is done. If full shaded, the drawing of the lines will necessarily have to be made closer together. When printed the effect would be lost entirely, as the finer lines would become filled with ink, producing a solid black mass. The cause of this is the lower quality of paper and ink used, together with the high rate of speed at which they are printed.

Shadows are those parts which are debarred from the rays of light which would fall upon them if it were not for some opaque body intervening. The portion of such opaque body which is turned from the light is in shade; that which is toward light is bright. The source of light in a picture is called a luminary. Luminaries are of three kinds—natural, artificial and secondary. Natural luminaries exist in nature, such as the sun, moon, stars, etc. An artificial is the result of art, as lamp-light, magnesium, electric light, etc. Light is secondary when emanating from natural or artificial sources, but passing through an aperture, such as a door or a window.

Light is reflected from all opaque surfaces, more from smooth or polished surfaces than from rough; the angle of reflection is equal to the angle of incidence. Light is reflected

more to a near object than a distant one. Take, for instance, the Fig. 9.

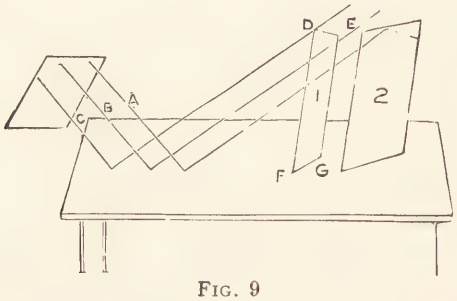


FIG. 9

The three rays of light, *a*, *b*, *c*, pass through the hole in the roof, falling upon a table; the rays are reflected from the table upon the plane, *d*, *e*, *f*, *g*; in this position all the rays strike the surface of the plane. If it was moved back to the position as represented by 2, only one ray would strike the plane, the others passing over it. The shadow of any object is always darker than the object itself, even on the side that is in the shade, and there is no light reflected upon the shadow itself.

When a shadow falls partly on a horizontal and partly on a vertical plane, the points at which the rays intersect the vertical plane in conjunction with vertical continuations of the lines on the horizontal plane determine the vertical continuations of the lines.



FIG. 10

This example is plainly illustrated in Fig. 10.

Sketching.

The greatest mistake with beginners when sketching, is in selecting the proper stand-point. The distance from the object shall not be less than the width of the latter. When the distance equals the width of the scene the angle of vision will not be much less than 60 degrees, which is the greatest the eye can take in at one view. Having determined on and taken your position, draw the base line with a T square. Then proceed to measure off the scene with an inch ruler held in the hand at the proper distance and on a level with the eye and the part of the object to be measured. By placing the rule at various angles so as to correspond with the picture the entire scene can be perfectly drawn and measured. In Fig. 11 let *a. b*,

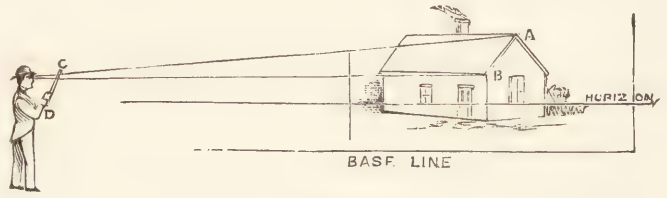


Fig. 11

represent a part of the scene to be sketched; *c*, *d*, on inch rule held in the hand on a plane with the line of the roof *a*, *b*, By looking over the edge of the rule the distance in inches that is to be measured off on the paper will be shown on the rules between the lines running from *a*, *b*, to the eye. When the rule is changed to different positions for measurement, care should be taken to hold the rule the same distance from the eye each time, otherwise the measurement will not correspond in each case. The farther away the ruler is held from the eye the wider will be the space on the ruler. In figure 12 it will be seen that the distance between the lines running from the corners of the frame *a*, *b*, to the eye is only one-fifth the distance on one as on two. With the above assistance, with frequent and careful reference to the scene, you will be able to draw the objects in their proper places and in perspective. Care should be taken not to make too many

lines: use the smallest number that will correctly denote the character of the object. The representation of the different objects in the scene should be carefully studied, as, for

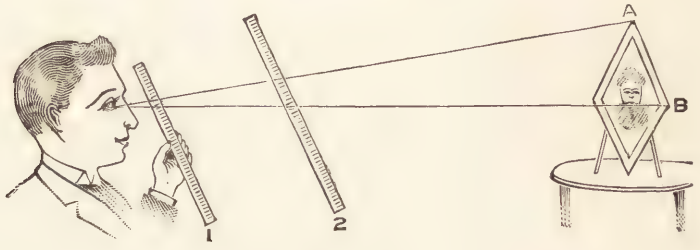


FIG. 12

instance, a tree in the foreground, the shading and detail should be more than one in the distance, the foliage and branches should be denoted. The same tree at a distance should be shown by marks less decided by making the outline only, with little shading. This makes the drawing have a distant effect and increases the perspective.

It is generally the case with beginners to give to each individual object its own light and shade without regard to the effect.

The result is that the picture is cut up into a great number of lights and shadows of about the same size and intensity, covering the entire surface of the picture. This is disagreeable to the eye, as it cannot rest with admiration on a single part, as the whole seems to claim the same attention.

By placing the principal objects in one larger and more intensely illuminated space, and by making other lights inferior to it, regulating the contrasts between the lights and shadows according to distance, this tends to direct attention to the principal objects.

There should also be one leading shadow with all others inferior to it. The same scene is shown in Fig. 14 as in the previous figure, but with different arrangement of color.

Every landscape may be divided into three parts—distance, middle and foreground.

Distance does not generally form an important part. It is to overcome both light and shadow, not having much to do with the general arrangement of the picture.



FIG. 13



FIG. 14

The middle picture generally embraces the largest breadth of shade. In the foreground is represented the deepest shadows as well as the strongest lights. It is sometimes the case that the foreground is in full shade, the principal light falling on the middle. When such is the case it is well to draw a few strong and scattered lines of light falling on objects in the foreground; this makes a good contrast with the dark tints.

CHAPTER II.

CHEMICALS USED IN PHOTO-ENGRAVING.

In order to more clearly understand the preparation of chemicals used in photo-engraving, an outline description of each of them will be given.

Chemistry makes us acquainted with the composition of different forms of matter and the changes they are capable of inducing in each other. Organic chemistry treats of substances existing already formed in the bodies of plants and animals—organized beings.

Inorganic chemistry is confined to substances belonging to the mineral kingdom, to matter having no parts or organs. Elements are simple substances, consisting of but one kind of matter; but it is possible that some of the substances now considered elementary may prove eventually to be in reality compounds consisting of two or more elements. The number of elements known at present is sixty-four: fifty-one are considered metals and thirteen non-metals. The elements are divided into two classes: those which unite with oxygen to form bases are termed metals, and those which unite with oxygen to form acids are called non-metallic.

Chemical affinity is that force which causes the elements of matter to unite and form new compounds. It acts at distances so slight as to be unrecognizable and upon the most dissimilar substances.

Compounds are of properties very much different from those of their elements—for instance, inert charcoal, hydrogen and nitrogen, compounded from the deadly prussic acid; poisonous and offensive chlorine combines with the metal sodium and forms common salt.

Heat and light favor chemical action and frequently develop an affinity when it seems to be needed.

Heat accumulating in bodies penetrates into their pores;

uniting with their molecules giving rise to a repellent force which counteracts those of cohesion. Therefore heat causes bodies to expand, and, if applied strong enough, the particles of solids are far enough repelled to move freely among each other and become liquid. If greater heat be applied the liquid passes off into vapor.

Light falling on a surface is divided into two parts: one enters the body and the other is reflected. The smoother the surface, the more is reflected and less enters the body. The amount reflected varies with the angle at which light falls.

Symbols are used for the sake of brevity. The initial letter of the name is used whenever distinctive enough, but when several bodies have names beginning with the same letter some other letter is associated with it. Thus, C stands for carbon, Ca for calcium, and Cd for cadmium. Confusion is liable to occur from words beginning with the same letters, first and second; by using for one the Latin name of the substance, distinction is made. For example do silver and silicon both begin with Si; by expressing the former with the Latin name Argentum, or Ag, all doubt is cleared up.

When more than one atom of an element is used to form a molecule of a compound, it is shown by writing the number below the symbol. Thus, H_2O indicates that there are two atoms of hydrogen and one of oxygen in a molecule of water.

A molecule is the smallest particle of a compound which can exist and consists of two or more atoms of elements. An atom is a particle of matter so small as to admit of no division. They are conceived to be the first principles or component parts of all bodies.

By *atomic weights* we express the proportions by which various elementary substances can unite together to form a new body. It is necessary that one element be selected as the starting point of the series, and an arbitrary sum affixed to it, and thereafter all the other elements can have their sums awarded to them according to the proportional amounts in which they combine with each other.

Hydrogen being the lightest substance known, is generally employed for this purpose. Its atomic weight is marked 1.

Nomenclature of the Elements.

The elements which have been known from the most remote period retain their common names, also their Latin names to some extent. Others bear the name of some distinguished feature by which they are characterized, Thus phosphorus from the Greek *light* and *to carry*, from its property of shining in the dark.

Constitution of Bodies.

All bodies are considered to be collections of molecules, as molecules are of atoms. In some of the elementary substances the molecule and the atom are the same, but in many kinds of matter several atoms are combined to form a molecule. Thus the molecules of nitrogen, chlorine, and oxygen contain two atoms each, and arsenic and barium four. The molecule of a compound always contains two or more atoms. The molecule is destructible, but the atom is not The specific properties of a substance reside in the molecule, and to break up the molecule is to destroy the substance. A physical change goes no further than the molecule, therefore does not affect the integrity of a substance; but a chemical change consists in a re-arrangement of the atoms, and formation of new molecules; therefore new properties. Whenever a combination takes place it is by elementary atoms and not by molecules.

Atomic Theory.

Analysis shows that compound bodies contain elements in certain proportions. These proportions have been minutely and carefully examined by many chemists since the time when the balance was first applied to chemical investigation, and it has been proven that the respective quantities of each of the combining elements are not dependent entirely upon external conditions, but are regulated by certain laws. These laws were partially observed and discussed by earlier chemists, but it was reserved for Dalton to systematize the irregular labors of his predecessors, and to announce in positive language the four laws which regulate the union of various kinds of substances, and which are still acknowledged by chemists as the

Laws of Combining Proportion, or the Atomic Theory. These laws regulate the combination of unlike substances by weight and not by volume, and they are based upon the preliminary acknowledged fact, capable of experimental demonstration, that the same compound substances are always composed of the same ingredients or elements.

The Laws of Atomic Theory.

1. Each element is composed of indivisible atoms which are exactly equal in size and weight.
2. The atomic weights represent the relative weights of the atoms of various kinds.
3. Compounds are formed by the union of atoms of different kinds in the proportion to their atomic weights or multiples of them.
4. The molecular weight of a compound is equal to the sum of the atomic weights of its elements.

Binary Theory.

A binary compound is a union of two elements. It is assumed all salts contain merely two substances, either both simple, or one simple and the other a compound, playing the part of a simple body. Thus common salt, chloride of sodium (NaCl), in which is combined the metal sodium (Na) with the non-metal chlorine (Cl) will be seen to be a binary compound (a compound of two). Likewise fluor-spar or the fluoride of calcium (CaF) consists of the metal calcium (Ca) and the non-metal fluorine (F), iodide of potassium (KI) largely employed in photography, of potassium (K), and iodine (I), and bromide of silver (AgBr), also much used in photography, of silver (Ag) and bromine (Br).

Acids, Bases and Salts.

There are two large classes of oxides chemically opposed to each other, termed acids and bases; their compounds are termed salts.

An acid is a chemical compound distinguished by the property of combining with bases in definite proportions to

form salts. The most striking characteristics of acids are a sour taste and the property of reddening vegetable blue, such as the infusion of blue litmus, to a bright red. The acids are named from the elements with which oxygen (O) combines The termination indicates the amount of oxygen, *ic* representing the greater and *ous* the lesser. Thus sulphur forms two acids of different strength: sulphuric, the stronger, sulphurous, the weaker. If an acid has been found to contain more oxygen than the stronger, it takes the prefix *per;* one having less than the weaker, the prefix *hypo.* Thus chlorine combines with oxygen and hydrogen to form a series of acids in regular gradation.

The bases are commonly oxides of the metals. Their terminations, as in acids, indicate the amount of oxygen. Thus mercury has two oxides—HyO and Hy_2O, termed respectively mercuric oxide and mercurous oxide; the alkalis are bases which are soluble in water, having a soapy taste and touch, turn red litmus to blue, neutralize the acids and restore the colors changed by them.

The salts are compounds which are formed by the combination of a base with an acid. In naming a salt the termination of the acid is changed, an *ic* acid forming an *ate* compound, and an *ous* acid an *ite* compound; thus the salts of sulphuric acid are called sulphates and of sulphurous acids sulphites, of nitric acid, nitrates, and of nitrous acids, nitrites.

Decomposition.

The separation of the simpler substances from a compound is termed decomposition. Thus when red oxide of mercury (HyO) is heated, it suffers decomposition, and is resolved into mercury (Hy), and oxygen (O). And water (H_2O), subjected to a current of electricity is decomposed into hydrogen (H) and oxygen (O).

Crystallization.

When bodies turn slowly from the liquid to the solid form the particles, instead of placing themselves irregularly, group into regular geometrical forms, called crystals; the proc-

ess of their taking these forms is called crystallization. The same substances under similar circumstances always assume the same shape.

Soluble substances are crystallized by the evaporation of their saturated solutions. If strings be suspended in hot solutions crystals will form upon them during cooling or evaporation; in this manner rock-candy, blue vitriol (sulphate of copper), alum, etc., are crystallized. Crystallization is sometimes the result of chemical re-action; silver, for instance, precipitated from its solution by zinc, forms a crystalline solution.

Concentration.

The evaporation of a part of a liquid in order to increase the strength of the remainder is termed concentration. Thus the silver bath may, through accident, be too much diluted; it can be strengthened by concentration.

Decantation.

The operation of pouring off the clear portion of a liquid from its sediment, or when transferring from one vessel to another, is performed by gently inclining the vessel or by



Fig. 15

means of a syphon. If, however, a syphon cannot be used and the vessel has no mouth or lip, and whose side is straight,

the liquid is apt to flow down the outside. This can be prevented by holding a glass rod or stick, previously wetted, in the liquid nearly upright, with one end resting in or suspended over the receptacle into which the liquid is to be poured. The liquid is generally poured down the upper side of the stick, keeping it in contact with the vessel. The liquid being more strongly attracted by the wet stick than by the dry side of the vessel.

The syphon is a tube of glass or metal bent at an angle of about 30 deg., with one leg longer than the other. The syphon must first be filled and the shorter leg inserted in the liquid, care being taken to keep its extremity always below the surface, and the liquid will flow continuously out of the longer leg as long as there is any left in the vessel.

Filtration.

The forms of filters and the substances of which they are composed are various and depend upon the nature of the liquids for which they are intended. The filtering medium

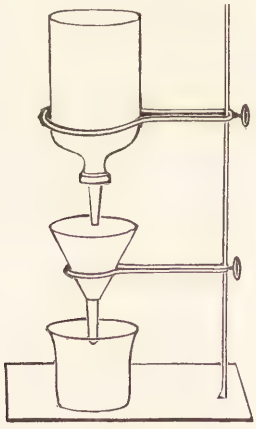


Fig. 16

may be any substance sufficiently spongy or porous to allow free percolation of the liquids. Unsized paper or cotton is generally employed. It is often of great advantage to make a

filter self-acting, or in such a way that it will feed itself, so that it can without attention be constantly in operation.

The end of the supply pipe should be fitted with a half-cock to keep the liquid in the filter constantly at the same height.

Precipitation.

This is a method of obtaining solid matter by mixing two or more solutions of substances containing certain elementary equivalents which have a strong mutual chemical affinity. That fluid which is added to another to produce precipitation is called the precipitant. The precipitant is added gradually, stirring the mixture constantly with a glass rod until precipitation ceases. The liquid is then allowed to settle until clear.

Saturation.

A liquid is said to be saturated with a soluble substance when it ceases to dissolve any more of it. An acid is saturated with an alkali when sufficient of the alkali has been added to completely neutralize the acid.

Solution.

A substance is said to undergo solution or to become dissolved when the force of adhesion between it and the liquid in which it is immersed is sufficient to overcome the force of cohesion between the solid particles. Thus sugar or salt is dissolved by water, camphor, or some resins by alcohol. The liquid which effects the solution is termed the solvent. Some solutions have a special name, thus syrup is applied to a solution of sugar and water, and tincture to the solution of a solid in alcohol.

Efflorescence.

When a salt loses its water of crystallization and presents a white, powdery appearance on the surface, it is termed efflorescent. Common washing soda exposed to the air affords a good illustration.

Deliquescence.

When a crystalline substance, on exposure to the air, absorbs water and becomes converted into a liquid or a semi-liquid mass it is said to be deliquescent.

CHEMICALS USED IN PHOTO-ENGRAVING.

Acetic Acid.

$C_2H_4O_2$ Mol. W. 60.

Is a colorless liquid, forming from two to four per cent. of common vinegar, whence its name. The strongest acetic acid is known as "glacial," it crystallizes as an ice-like solid at about 63 deg. It has an aromatic taste and pungent odor, and after a time blisters the skin. It possesses the property of dissolving a number of substances such as volatile oils, camphor, resins, albumen, gelatine, etc. As it attracts humidity from the atmosphere it should be kept in well-stoppered bottles. Acetic acid No. 8 is generally used in the developer.

Carbolic Acid.

C_6H_5OH Mol. W. 94.

Is also called phenol, phenic acid, hydrate of phenyl. It consists of long colorless prismatic crystals, which melt at about 90 deg. Fahr. into an oily liquid resembling creosote. The crystals deliquesce in moist air, forming a sort of hydrate, which boils at 370 deg. and has a specific gravity of 1.065. When heated with ammonia it yields aniline and water, and nitric acid converts it into picric acid. Commercial creosote consists principally of hydrated carbolic acid, but is easily distinguished from it, as carbolic acid coagulates collodion, and creosote does not. It is added to gum-arabic solution to keep it from souring.

Citric Acid.

$C_6H_5O_7 + H_2O$. Mol. W. 210.

Citric acid is a white crystallized solid, often in large crystals. It is permanent in dry air, but becomes moist in a damp one. It is found in the juice of lemons, cranberries, gooseberries, and strawberries. It dissolves in three-fourths of its weight of cold, and half its weight of warm water. It is also soluble in alcohol.

Citric acid is used as a clearing solution when applied to the negative after intensifying.

Gallic Acid.

$H,C_7H_5O_5+H_2O$. Mol. W. 170.

Gallic acid is associated with tannin in nut-galls and can be formed from tannic acid. It is in the form of colorless silky needles which lose their water of crystallization at 212 degrees. They dissolve slightly in cold water, but require only three parts boiling water for their solution; they are also freely soluble in alcohol. Gallic acid posssesses the property of reducing the salts of gold and silver; it is on this account employed in photography.

Muriatic or Hydrochloric Acid.

HCl. Mol. W. 36.5.

Is obtained by the action of sulphuric acid on chloride of sodium (common salt). When pure it is a transparent colorless liquid of a suffocating odor and corrosive taste. It is much absorbed by water which takes up several hundred times its own volume of gas. It is generally employed in photography as a cleaning solution and as a mordant when etching, and for several other purposes.

Nitric Acid.

HNO_3. Mol. W. 63.

So called from nitre, is a liquid extremely acid and corrosive. When perfectly pure it is colorless, but as usually obtained it has a straw color, owing to the presence of nitrous acid. By the action of light it undergoes a slight decomposition and becomes yellow. It stains the skin and most animal substances of an indelible yellow color.

This acid is found in nature, combined with potassium or sodium. It is formed in small quantities in the atmosphere by the union of its elements during the passage of electric fluid as in a thunder-storm.

It is prepared by adding a stronger acid to one of the nitrates. Thus, if sulphuric acid and sodium nitrate be heated together in a retort the salt will be decomposed, and the acid can be collected in a receiver. In photo-engraving it is used for many purposes, mainly etching.

Albumen.

Is found nearly pure in the whites of eggs. It exists in two amorphous conditions—as a liquid in the sap of plants, the humors of the eye, serum of the blood, etc., and as a solid in the seeds of plants and the nerves and brains of animals.

It is soluble in cold, but insoluble in hot water. At a temperature of about 140 deg. Fahr. it coagulates. This change is seen in the cooking of eggs, yet the cause is not sufficiently explained.

It is a valuable antidote in cases of poisoning by bichloride of mercury, acids, creosote, and solutions of copper, lead, silver, etc.; it wraps them in an insoluble covering and so protects the stomach.

It is a useful vehicle in carrying the sensitizing agent and binding it to the zinc when printing.

Alcohol.

C_2H_5OH Mol. W. 46.

Alcohol is prepared by distilling wine, whiskey, or other liquids, the result of saccharine fermentation. Alcohol is a colorless, transparent, volatile liquid of a penetrating, agreeable odor and strong, burning taste. When free from water it is called anhydrous, or absolute alcohol. When pure it is a deadly poison, is inflammable, and burns without smoke or residue, the products being water and carbonic acid.

It dissolves numerous salts, resin, camphor, and volatile oils.

To detect the amount of water in it, put some in a spoon and inflame it; what remains, after the flame has expired, is water.

If it shows a trace of acidity it may be neutralized with ammonia, a drop being enough to neutralize half a gallon of alcohol.

Alum.

$Al_2(SO_4)_3,K_2SO_4,24H_2O$ Mol. W. 948.

Alum is made by treating clay with sulphuric acid, forming aluminium sulphate. On adding potassium sulphate a double salt is produced, which separates in beautiful octahedral

crystals. Instead of potassium an ammonium salt is now generally added, and an ammonium alum made which takes the place of the former in the market.

Ammonia Liq. Conc.

NH_3. Mol. W. 17.

It is prepared by heating chloride of ammonium (sal ammoniac) in a retort with slacked lime. The gas evolved is absorbed by water in the receiver. It is a colorless liquid, of a caustic, acrid taste, and very pungent smell, and is strongly alkaline.

Ammonia is found useful in many places in photography, such as fuming sensitized paper, and by adding to albumen solution for sensitizing zinc; also for neutralizing the silver bath.

Ammonium.

NH_4.

This compound has never been separated, but is now generally agreed by chemists to be the basis of the salts of ammonia.

Ammonium Bichromate.

$(NH_4)_2Cr_2O_7$. Mol. W. 253.

Comes in the form of red prismatic crystals; the inferior grades are denoted by their muddy color. It is used as a sensitizer of albumen or gelatine for printing on zinc and photo-lithographic transfer papers.

Ammonium Bromide.

NH_4Br Mol. W. 98.

For the preparation of bromide of ammonium bromine is added very gradually to diluted ammonia and evaporated in an iron retort. It is soluble in water and alcohol. Is used in the preparation of collodion.

Ammonium Chloride.

NH_4Cl. Mol. W. 53.5.

Also called sal-ammoniac; is prepared from the ammoniacal liquor of the gas works. It comes in tough fibrous crystals. It is used much for salting paper, preparatory to sensitizing it with silver nitrate.

Ammonium Iodide.

NH_4I. Mol. W. 145.

This salt is formed by placing iodine in a flask with a little water and adding to it a solution of sulphide of ammonium until the mixture loses its color. It is then filtered and evaporated over a flame, constantly stirring. It is soluble in alcohol and water. It is used in the preparation of collodion.

Ammonium Sulphuret.

NH_4HS. Mol. W. 51.

Also called hydrosulphuret or hydrosulphate of ammonia. It is prepared from strong liquor of ammonium, by saturating it with sulphuretted hydrogen gas, and then by adding a second portion of liquor ammonium. It is a liquid of a greenish-yellow color, of very fetid smell, and acrid, disagreeable taste. It readily decomposes by exposure to air, and should be kept in well-stoppered bottles.

It gives colored precipitates with neutral metallic solutions; for this reason it is useful in photography as an intensifier.

Asphaltum or Bitumen.

Asphaltum is a black and friable fossil resin of conchoidal fracture, insoluble in water, but certain equivalents dissolve in ether; that part which is insoluble, is sensitive to light and is used for printing on zinc.

Asphaltum is found in immense quantities in California, Missouri, and in Canada and Trinidad. For photographic purposes, that coming from Syria is preferred. It is a natural cement and resists acids or alkalies and used for coating trays and etching tubs.

Benzole.

C_6H_6 Mol. W. 78.

This substance was originally obtained by distilling benzoic acid with lime. It is now, however, distilled from tar. It is a solvent of many of the resins, also of mastic, camphor, wax, caoutchouc and gutta-percha. The last two substances may be obtained without alteration of properties in tough sheets by spreading the benzole solutions on glass and allowing to evaporate.

Cadmium Bromide.

$CdBr_2 4H_2O$ Mol. W. 344.

This is prepared by mixing iodine and cadmium filings and bromine. It consists of long white efflorescent crystalline needles. Dissolves in water and alcohol. It is used in the preparation of collodion.

Cadmium Iodide.

CdI_2 Mol. W. 294.

This is prepared by mixing iodide and cadmium filings in a moist state. It is freely soluble in alcohol and water, and may be crystallized by evaporation from either solution in large white transparent crystals; used in preparation of collodion.

Calcium Chloride.

$CaCl_2$ Mol. W. 111.

Is also known as muriate of lime. From the strong affinity it has for water it is much used for drying gases and absorbing the water from ethereal and oily liquids. In organic analysis for this purpose it is used dry. It is also used in the preparation of freezing mixtures with snow. This salt should not be left uncorked, as it rapidly deliquesces. Used in making collodio-chloride.

Bichloride Mercury (Corrosive Sublimate).

$HgCl_2$ Mol. W. 271.

Is prepared by boiling mercury in sulphuric acid by means of a sand bath. When cold rub the dry white mass with chloride of sodium, then sublime with a gentle heat. It is sparingly soluble in water, but more freely in alcohol. Used for bleaching prints and intensifying negatives.

Ether Sulphuric.

C_4H_5O Mol. W. 57.

Sulphuric ether is obtained by adding sulphuric acid to alcohol and then distilling. It is a colorless limpid liquid of a peculiar and fragrant odor. It burns with more light and produces more smoke than alcohol. As few of the salts can be dissolved in ether they are to a certain extent precipitated

when alcohol containing such salts are added to it. The vapor of ether is very heavy and inflamable; it should be kept away from any flame. In photography it is used in the preparation of collodion.

Gum-Arabic.

Comes from certain species of the acacia tree, and is formed similar as the gum from peach and cherry trees, by exudation and spontaneous drying. It is more or less transparent, hard and brittle, generally white or yellowish-white, bleached by exposure to the light of the sun, insoluble in alcohol or ether but soluble in water and diluted acids. Its solutions remain a considerable time unaltered, but ultimately become acid. This tendency to become acid is increased by employing hot water to dissolve it. Used to gum the zinc plate when etching.

Iodine.

I Mol. W. 127.

Iodine exists in certain marine plants, particularly the fuci or common sea-weeds, and in some fresh-water vegetation, among which are the water-cress and brookline. It is a soft, friable substance in the form of crystallic scales, having a bluish-black color and metallic lustre. Iodine is soluble in alcohol and ether, but requires 7000 times its weight of water to dissolve it.

Iron Sulphate (Ferrous).

$FeSO_4 7H_2O$ Mol. W. 278.

Protosulphite of iron, or ferrous sulphate, is known also as copperas, green vitriol, etc. It is made by treating iron with sulphuric acid. It is in the form of transparent crystals of a pale, bluish-green color and efflorescent in the air. Sulphate of iron is soluble in about twice its weight of cold water and in three-fourths of its weight of boiling water, but is insoluble in alcohol. Used in developing the latent image on collodion plates.

Kaolin.

$H_2Al_2Si_2O_8 + H_2O$. Mol. W. 258.8.

Kaolin is the name given by the Chinese to a fine white clay which they use in making their porcelain. It is a decomposi-

tion of granite. It is insoluble in water and acids, and is used in photography to carry down impurities in the silver bath.

Litmus.

Litmus is a well-known coloring matter which is obtained from several lichens, but chiefly from lacanora tartahia. The lichens are powdered and digested with ammoniacal fluids (wine for example) till they undergo decomposition. Sand and chalk are added to give a due degree of solidity. It is used in preparing test papers. Acids turn blue litmus paper red, and alkalis restore it to the original color.

Palm Oil.

This valuable fixed oil is the product of a palm tree cultivated in South America, but mainly so in Africa. It has the consistence of butter, and is of rich, orange-yellow color. It is sparingly soluble in alcohol, but more so in ether. It is used in the manufacture of lithographic transfer and etching inks.

Potassium Bichromate.

$K_2Cr_2O_7$ Mol. W. 295.

This salt is prepared from the neutral or yellow chromate of potassium. It is in the form of orange-red anhydrous prismatic crystals, soluble in ten parts of cold water, but insoluble in alcohol. Is used as a sensitizer of gelatine and albuminous films.

Potassium Bromide.

KBr. Mol. W. 119.

Bromide of potassium is made of bromine, iron filings, carbonate of potassa and water. It is a permanent, colorless anhydrous salt, in cubes or quadrangular prismatic crystals. It is very soluble in water, but slightly in alcohol. Used as a sensitizer for collodion and other carriers.

Potassa Caustic.

KO,HO. Mol. W. 57.

Caustic potassa is prepared by evaporating a solution of potassa till ebullition ceases and the potassa melts. It is

then formed into sticks. It is extremely caustic and very deliquescent and dissolves in less than its weight of water, is also readily soluble in alcohol. Used to clean negative glasses.

Potassium Cyanide.

KCy. Mol. W. 65.

Is prepared by mixing ferro-cyanide of potassium and carbonate of potassium, and roasting them in a red-hot earthen crucible. When pure this salt is colorless and odorless. Its crystals are cubic. If it be yellow it contains iron. Taken inwardly it is a deadly poison; liable to cause ulceration and blood-poisoning if it gets into cuts or sores. Is used as a fixing agent.

Potassium Iodide.

KI. Mol. W. 166.

Potassium iodide is formed by adding iodine to a solution of caustic potassa. It is in opaque, white crystals, soluble in water and alcohol. Chiefly used in sensitizing collodion and other photographic films, and in combination with mercury as an intensifier.

Potassium Permanganate.

$KMnO_4$. Mol. W. 158.

Is obtained by a mixture of peroxide of manganese with chlorate of potassa. It is in the form of slender prismatic crystals of a dark purple color. It is a powerful disinfectant and oxidizing agent. Used in rectifying the silver bath.

Potassium Sulphuret, or Sulphide.

K_2S. Mol. W. 110.

Prepared by rubbing together sublimed sulphur and dry carbonate of potassa and heating in a covered crucible. Sulphuret of potassium is a hard, brittle substance. Its color is liver-brown, hence its name liver of sulphur. It emits a fetid smell, is completely soluble in water, and is used in photography as an intensifier and to precipitate silver in the form of sulphide of silver from waste solutions.

Ammonia-Nitrate of Silver.

Is formed by adding ammonia, a few drops at a time, and thoroughly mixing to a nitrate of silver solution in water, until the brown precipitate first formed is redissolved. All hand-books of photography give detailed formulas of how to prepare this solution. Its chemical constitution is not distinctly understood, but this preparation is very frequently employed to sensitize mat-surface printing papers.

Silver Bromide.

AgBr. Mol. W. 188.

Is found in Mexico, where it is known as plata verti or green silver, in the form of small crystals of a pale, olive-green tint. It can be formed by adding any alkaline bromide dissolved in water to a solution of nitrate of silver in water.

Silver Chloride.

AgCl Mol. W., 143.5.

By adding to a solution of nitrate of silver any of the soluble chlorides a white precipitate is formed, which turns violet and finally black if exposed to light.

Silver Iodide.

AgI Mol. W., 235.

Is formed by double decomposition when adding a solution of iodide potassium to one of nitrate of silver. It is a greenish yellow powder nearly insoluble in ammonia. Used to iodize the negative bath.

Silver Nitrate.

$AgNO_3$. Mol. W., 170.

Nitrate of silver is formed by dissolving metallic silver in nitric acid and evaporating to crystallization. It also comes in small round sticks known as lunar caustic. Nitrate of silver is the basis of mostly all photographic operations. Lunar caustic is nitrate of silver fused by strong heat, leaving a fine black powder, doubtless metallic silver reduced by excessive heat in fusing, wholly soluble in distilled water when pure, but even good samples of it will not totally dissolve.

Sodium Bicarbonate.

$NaHCO_3$ Mol. W., 84.

Is in opaque porous masses made up of numerous aggregated crystalline grains and having a snow-white color. It is soluble in thirteen parts of cold water. When the solution is exposed to heat the salt gradually parts with carbonic acid, and decomposes.

Sodium Chloride.

NaCl Mol. W. 58.5.

Common salt is white, without odor and of a peculiar taste, called saline. It is crystallized in cubes. This mineral production, so necessary to mankind, is universally distributed all over the globe.

Sodium Hyposulphite.

$Na_2S_2O_35H_2O$ Mol. W. 248.

This salt is formed by mixing dry carbonate of soda with sulphur and heating until melted. It is in the form of large, colorless, transparent crystals. Being a solvent for iodide, bromide and chloride of silver, hyposulphite of soda is used for fixing prints and negatives.

Strontium Chloride.

$SrCl_26H_2O$ Mol. W. 266-5.

Is a white crystalline salt, soluble in water and alcohol, and is used as a salter in various printing processes.

Water.

H_2O Mol. W. 9.

Water in a pure state is a transparent liquid, without color, taste or smell, and can be obtained only by distillation. Rain and snow waters are the purest kind of natural water and are suitable for photographic purposes if collected in the country at a distance from houses, and some time after the rain has commenced falling.

River water is less impregnated with saline matter than spring water from its being made up in considerable part of rain water. Hard water, or spring water containing mineral salts dissolved, should never be used for preparing of photographic chemicals.

Zinc Iodide.

$Zn.I_2$ Mol. W. 319.

Is formed by digesting an excess of zinc with iodine diffused in water. When thus prepared it is in the form of white needles. It is very liable to undergo spontaneous decomposition. Used chiefly in collodion.

Table of Symbols and Atomic Weight of Metallic and Non-Metallic Elements, together with Their Specific Gravity, Color and Solvent.

Note.—The names of metals are printed in Roman, non-metals in italics.

Name.	Symbol.	Atomic Weight.	Specific Gravity.	Color.	Solvent.
Aluminum . . .	Al.	27.5	2.67	White.	HCl
Antimony.....	Sb.	120.0	6.71	Bluish-white.	HCl3
Arsenic.....	As.	75.0	5.95	Steel-gray.	HNO_3
Barium.....	Ba.	137.0	1.85	Yellow.	
Bismuth.....	Bi.	208 2	9.799	Reddish-white.	HNO_3
Boron..... ..	B.	11.0	2.680	Brown.	$KHCO_3$hot
Bromine.....	Br.	80.0	3.187	Brownish-red.	Ether.
Cadmium	Cd.	112.0	8.604	Bluish-white.	H_2SO_4
Caesium.....	Cs.	133.0	Unknown.		
Calcium..	Ca.	40.0	1.578	Light yellow.	HCl dil.
Carbon.....	C.	12.0	2.35	Black.	Insol.
Cerium	Ce.	145.0			
Chlorine.....	Cl.	35.5	2.435	Green.	H2O
Chromium	Cr.	52.5	6.810	Gray.	HCl
Cobalt.....	Co.	58.6	8.95	Steel-Gray.	HCl
Copper.....	Cu.	63.4	890	Red.	H_2SO_4
Didymium....	D.	146.0			
Erbium.....	E.	165.9			
Fluorine.....	F.	19.0	1.31		
Gallium	Ga.	68.8	4.7		
Glucinum	G.		2.10		
Gold	Au.	196.7	19.34	Yellow.	$HCl.+NO_3$
Hydrogen.....	H.	1.0	.069	Colorless.	
Indium	In.	113.4	7.20	White.	
Iodine.....	I.	127.0	4.94	Bluish-black.	Ether.
Iridium.....	Ir.	192.5	21.80	White.	Insol.
Iron	Fe.	56.0	7.80	Gray-white.	Acids.

TABLE OF SYMBOLS, ETC.—*Continued.*

NAME.	SYMBOL.	ATOMIC WEIGHT.	SPECIFIC GRAVITY.	COLORS.	SOLVENT.
Lanthanium..	La.	138.5			
Lead.....	Pb.	207.0	11.36	Bluish-white.	NO_3
Lithium	L.	7.0	0.59	White.	
Magnesium...	Mg.	24.0	1.70	White.	Acids.
Manganese ...	Mn.	55.0	8.00	Gray-white.	HCl
Mercury	Hg.	200.0	13.596	White.	NO_3
Molybdenum..	Mo.	95.0	8.64	Gray.	HNO_3
Nickel.....	Ni.	58.8	8.90	White.	HCl
Niobium.....	Nb.	94.0			
Nitrogen	N.	14.0	.971	Colorless.	
Osmium	Os.	199.0	21.400	Bluish-white.	
Oxygen	O.	16.	1.1056	Colorless.	
Palladium	Pd.	106.5	11.12	White.	NO_3
Phosphorus....	P.	31.0	1.83	Colorless.	CS_2
Platinum	Pt.	194.4	21.58	White.	$HCl+NO_3$
Potassium....	K.	39.0	.865	Bluish-white.	
Rhodium	Ro.	104.3	11.00		
Rubidium,....	Rb.	85.4	1.52	White.	
Ruthenium....	Ru.	104.2	11.12		
Selenium.....	Se.	79.4	4.80	Brown.	CS_2
Silicon	Si.	28.0	2.49	Brown.	NO_3+HFU
Silver.....	Ag.	107.7	10.50	White.	NO_3
Sodium	Na.	23.0	.972	White.	
Strontium.....	Sr.	87.5	2.54	Pale-yellow.	dil.HNO3
Sulphur.....	S.	32.0	2.00	Yellow.	CS_2
Tantalum.....	Ta.	182.0	10.78		
Tellurium	Te.	125.0	6.65	Reddish-white.	H_2SO_4
Thallium	Tl.	204.0	11.86	White.	NO_3
Thorium	Th.	231.5			
Tin	Sn.	118.0	7.3	White.	HCl
Titanium	Ti.	50.0	5.3	Gray.	HCl
Tungsten	W.	184.0	17.50	Steel-gray.	NO_3
Uranium.....	U.	238.5	18.40	Gray.	
Vanadium....	V.	51.3	3.64		
Yttrium.....	Y.	61.7			
Zinc.....	Zn.	65.2	7.15	Bluish-white.	H_2SO_4
Zirconium	Zr.	89.6	4.15	Black.	H.FU

CHAPTER III.

APPARATUS AND THE WORK-SHOP.

Unless you intend to erect a building for the purpose of photo-engraving, it will be no easy matter to find suitable rooms, which do not require alterations, such as putting in a skylight, partitioning into rooms, etc.

Each separate division of the work should be carried on in separate rooms, independent of each other.

As a general thing photo-engraving shops are started on a small scale, and generally located in the upper stories of buildings erected for other purposes, some being fortunate enough to get suitable rooms on the floor next the roof, where a skylight can be built without much expense.

The camera room should be sufficiently large to admit of the camera being moved around in order to get the proper light. In this room should be several larger tables for the proper handling of the copy, etc.

Immediately adjoining the camera room is the dark-room, divided in two parts. One part provided with a large sink, running water and a window, covered with a non-actinic medium, such as yellow or ruby glass.

This room is used for the development of the negatives, keeping the silver baths, negative glasses, and developing solutions.

The adjoining room is used for preparing the chemicals, etc. In this room a sink is also located, where intensifying is done.

The printing room does not necessarily have to be as large as other dark-rooms, but it should be provided with a sink, running water and window, closed with yellow glass. A gas or coal-oil stove is used for drying the zinc plates after sensitizing. A bench large enough to hold an inking slab about twenty inches square, and several printing frames of different sizes.

The finishing room should be provided with a long, heavy bench, upon which the finishers' plates and vaces are placed.

A router, circular saw, trimmer, shoot board and planes, and proof press are all the machinery necessary for a medium-sized shop, employing from 10 to 12 hands.

The router should be located, if possible, so as to get light from two sides.

All rooms should be kept perfectly clean, and as free from dust as possible. The camera-rooms and dark rooms should be mopped every morning. The walls and ceilings of the camera room should be painted white. Light reflected from them assists to illuminate the copy. If the walls were painted red, the reflection would be red, and effect be at once perceptible.

Immediately under the skylight a platform should be built large enough to allow sufficient room to properly operate the cameras. Its height should be sufficient to place the cameras as near the skylight as possible. With this arrangement much better light is obtained than if the operating was done on the floor, lower down.

A room for printing by electric light is very desirable, the most convenient being one built similar to an ampitheatre, having the light hanging in the center, with shelves encircling it, one above the other, upon which the printing frames are placed. A path around the shelving admits of reaching any frame without disturbing others that are being exposed.

The camera generally used by photo-engravers is what is called the plain copying box. Some, however, prefer the enlarging, reducing and copying cameras.

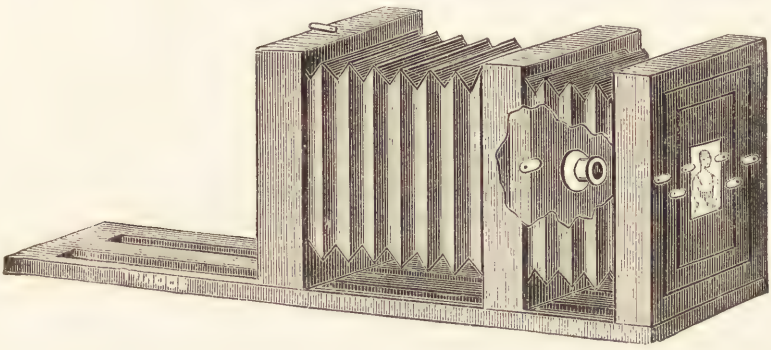
The form of construction of the latter is somewhat different from the copying camera.

The lens can be arranged on the end of the box for ordinary copying, or it can be placed on a board that works on the inside of the bellows, which arrangement permits of copying the negatives by placing them in kits that fit on the end of the box, when the lens is placed for ordinary copying. This makes it very desirable for working the half-tone process, known as the Meissenbach, or half-tone engraving.

The plate-holders usually sent out with these cameras have

kits with glass corners. This arrangement admits of the use of four different sized plates only.

As this is, at times, a great disadvantage, it is advisable to procure a holder that takes any sized plate. They can be



ordered with the camera in place of the old style holder with kits.

Instead of the stand upon which the camera is generally placed by photographers, a swing is used, to suspend the camera from the ceiling. Fig. 17.

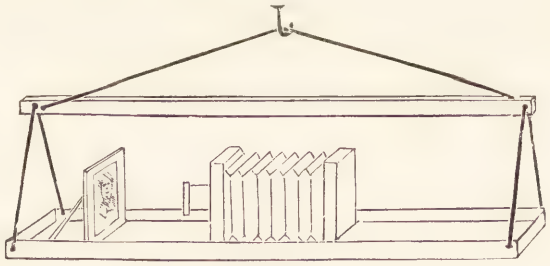


FIG. 17

A copy board made to slide back and forth is placed on the end of the swing in front of the camera. Upon this the drawing is tacked. With this arrangement, if the camera or copy should accidentally be moved, there is no danger of the negative being spoiled, as all move together.

It is not advisable to get a smaller sized camera than 11 x 14.

When in use, the plate holder should be kept perfectly clean, and varnished frequently with asphaltum varnish.

The camera should also be provided with a hood or a covering for the lens to keep out side or reflected light. Fig. 18.

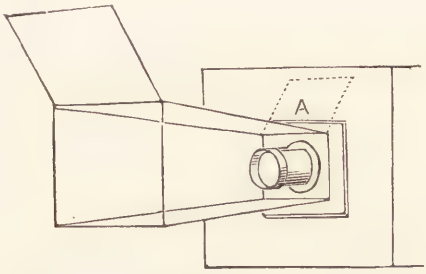


Fig. 18

It can be provided with a light-tight lid which can be used in place of the cap, another lid should alse be placed on the top at A, so that the stops can be changed.

The ground-glass generally sent out with cameras is of an inferior quality, being on common class, coarsely ground. Better select a good piece of glass, lay it on a level board and with some emery flour and water, and a smooth flat piece of steel, it can be ground in about fifteen minutes.

Lenses.

A lens is a transparent body with at least one curved surface, there being two general classes, concave and convex.

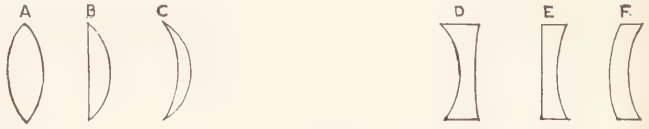


Fig. 19

A, B, and C, being thicker in the centre than on the margin, they are called convex lenses. The first three are styled magnifiers and the second diminishers.

Rays of light passing through either of the above undergo

different changes in their direction, according to its form and density. Thus, a convex lens, Fig. 20a, is to concentrate parallel rays passing through it, and bring them all to one point or focus.

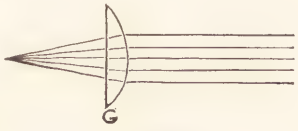


FIG. 20a

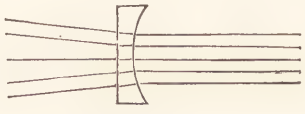


FIG. 20b

That of a concave lens, Fig. 20b, is to disperse rays, by throwing them wider apart from each other.

The forms of lenses are turned after the shape they assume: Fig. 19, A, double-convex; B, plano-convex; C, meniscus; D, double concave; E, plano-concave; F, concavo-convex.

By holding a convex lens above a printed page and obtaining the focal distance correctly, the letters will be right side up and greatly enlarged.

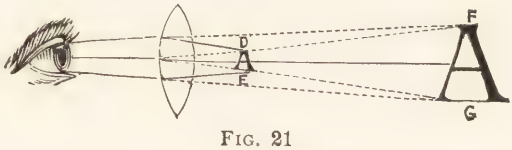


FIG. 21

The converging power increases the visual angle and makes the object D E appear the size of F G.

By moving the lens away from the page, the letters disappear entirely when the principal focus is reached. As the

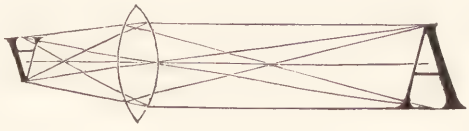


FIG. 22

distance from the paper is increased they will reappear again, but much smaller and inverted Fig. 22.

Concave lenses are exactly the reverse in every respect to

convex lenses, and therefore producing opposite results. The images produced by a concave lens are always smaller and erect. Fig. 23. It will be noticed that the rays from the candle strike the lens at different angles, some being refracted

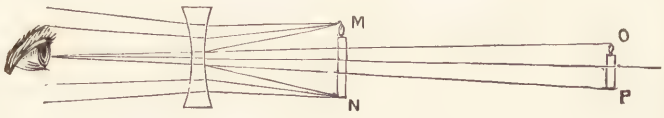


FIG. 23

so much as to miss the eye. Those only that pass through the center of the lens, lead to the eye, it is the reason why the image is seen under a small angle.

SPHERICAL ABERATION.

Rays which pass through a lens near the edge are brought to a focus sooner than those near the center. When focusing on an object, it will appear indistinct on the margins of the ground glass, or *vice versa*. The picture will, however,

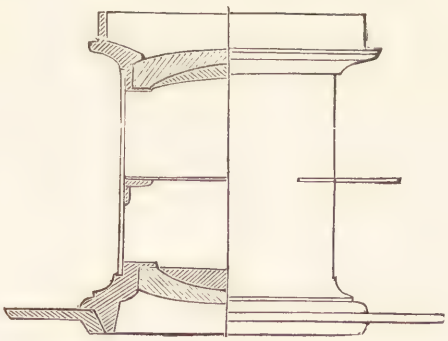


FIG. 24

become sharp when a stop is inserted. This prevents certain rays from falling on the lens, or preventing the action of such rays passing through marginal parts of the lens. The smaller the stop the sharper and the more distinct will be the image.

Chromatic Aberation.

The different refrangibility of the colors which compose white light produces chromatic aberation. The violet, being bent most, comes to a focus sooner than the red, which is bent least. This is the cause of the colors seen around the image produced by ordinary lenses. The remedy for this defect is by using a second lens of different dispersive power and a stop which counteracts the effect of the first.

The two lenses, front and back, are of equal distance from the stop. The rays passing through the front lens are distorted, striking the back lens, which is exactly opposite to the front, but become equalized.



1 2 3

Fig. 25

When focusing with a single lens A, with front stops on a square 1, Fig. 25, the image on the ground glass will appear curved like the sides of a barrel, 2. When using instead the same lens with the stop behind it, the curves will become reversed, 3.

Description of Lenses.

When selecting a lens too much care cannot be taken in regard to its construction, its quality for the purposes it is wanted, and for even those of highest reputation are not always perfectly free of faults.

The points to be looked after are—luminous power, uniform sharpness to the margin of the plate, equal intensity, coincidence of chemical and visual foci, distortion and perfect rectilinearity.

Before deciding upon a lens it should be subjected to a severe test.

Prisms.

In order to save turning films, prisms can be used to advantage. They are made of one solid mass of glass, with silvered hypothenuse.

They are fitted to the lens with a rotary flange, which allows being turned and fixed at any any angle, Fig. 26.

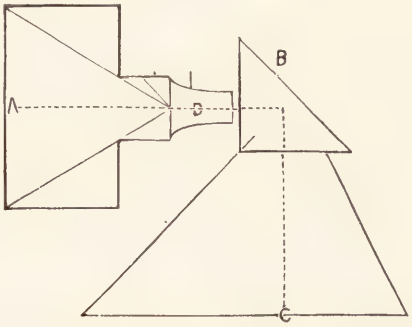


Fig. 26

The Bath Holder.

The bath is a narrow trough used for holding the silver solution. It is preferably made of glass, and enclosed in a light-tight box.

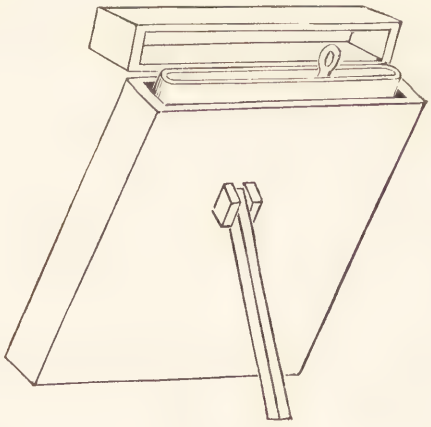


Fig. 27

Bath-holders made of India rubber are used occasionally, but the organic matter will be attacked in time by the silver nitrate,

despoiling holder and solution, and making them useless. Baths that hold 2½ gallons of solution are advisable. By using smaller ones, the solution can only be worked a short time before they becomes disordered and require rectification.

A bath of the above capacity, if properly made, should sensitize at least three hundred plates before showing signs of disorder, whereas a smaller one is likely to give out at any time.

CHAPTER IV.

PHOTOGRAPHIC PROCESSES AS APPLIED IN PHOTO-ENGRAVINGS.—PREPARATION OF THE CHEMICALS.

The preparation of the chemicals is the principal thing in photo-engraving as well as in photography, and must be conducted with the greatest accuracy and cleanliness if satisfactory results are expected.

Each preparation must be carried out with precision with no guessing at weights and measures.

Do not fix the idea on your mind that all that is necessary is to measure out the amount of chemicals the receipt calls for, and mix them one on top of the other, like shoveling dirt into a cart.

The errors made will manifest themselves in every plate, making success impossible.

By using dirty graduates, funnels, and mortars, the chemicals can be ruined, and will cause a hundred times more trouble than had the proper care been taken at the first.

Preparation of the Collodion.

Collodion is made by dissolving gun-cotton (pyroxyline) in a mixture of alcohol and ether, to which salts are added.

An excess of ether makes the film tough. It closes the pores, preventing intensity of the negative, and the collodion does not adhere firmly to the plate. The film can often be removed entirely from the plate without tearing it.

An excess of alcohol in the collodion produces opposite effects. It makes the film rotten and tears easily, but acts more favorably in regard to intensity.

The keeping qualities of collodion depend on the cotton and its preparation. It should be kept in a cool dark place in well-corked bottles.

Sensitizing Salts Used in Collodion.

It has been found by experience that iodides and bromides of acid reaction, such as the iodides and bromides of cadmium are the best. They are more permanent and add to the keeping qualities of the collodion.

Alkaline iodides and bromides such as those of ammonium and potassium decompose rapidly and become limpid.

The cause of collodion turning red is from the oxidation of the alkaline metals and by the nitrous acid in the gun-cotton.

Collodion.

The following formula will meet all requirements for making negatives suitable for photo-engravers' use.

When poured upon the plate it should be perfectly smooth and transparent.

A.

Alcohol, absolute	6 ounces
Ether, sulph. conc	10 ounces
Gun-cotton	112 grains

B.

Iodide of zinc	96 grains
Bromide of cadmium	108 grains
Alcohol	4 ounces

Put the cotton in a clean bottle of sufficient size and add the alcohol until the cotton is saturated with it; then add the ether, and shake until the cotton is dissolved.

The iodide of zinc is well ground in a clean glass mortar, the bromide of cadmium added, and both ground together until they appear like a pasty mass. When the remaining alcohol is added. When entirely dissolved the solution is filtered through filtering paper and added to the plain collodion. Shake well and let stand for a week to settle. If on trial and before the collodion has turned yellow there is a tendency to fog the plate, add a few drops of tincture of iodine.

Collodion, if made at too low a temperature, sometimes takes months to settle. Such collodion must be well filtered. When collodion becomes too thick by use, thin with ether only.

The Silver Bath.

Great care is essential to the proper preparation of the silver bath. Take a sufficient quantity of distilled water to fill your bath holder, and add to it 1 ounce crystallized nitrate of silver; dissolve and set in the sun. This will throw down any organic matter contained in the water, depositing it on the bottom of the bottle in the form of a black powder. When clear, filter through paper. Nitrate of silver is again added and dissolved until the hydrometer registers 40 grains to the ounce of water. Test with blue litmus paper; if acid add a few drops of concentrated liquid ammonia until neutral, and set in the sun as long as it is needed.

Iodizer.

Before the bath can be used, it must be iodized with

Iodide of ammonium.....10 grains
Water..... 7 ounces

and add thereto

Nitrate of silver..... ...25 grains
Water..... 4 ounces

Pour the silver solution into the iodide solution, which will immediately throw down a yellow precipitate of iodide of silver. The solution is now stirred well, and allowed to settle; the supernatent clear liquid is carefully decanted and fresh clean water added to wash the precipitate of iodide of silver. This operation is repeated five or six times; and the iodide of silver finally added to three-fourths of the bath. The uniodized portion is now filtered separately, and the iodized portion filtered into the uniodized afterwards. Nitric acid C. P. is now added drop by drop until blue litmus paper turns slightly red when immersed. The bath is now ready for use.

Some authorities recommend iodizing the bath by immersing a collodionized plate in the solution and leaving it there over night. That will answer the purpose very well when about a gallon of solution is to be iodized, but it is not practical in two or three gallons.

The Developer.

The sulphate of iron developer is generally employed. When a plate is coated with collodion and dipped in the silver bath, the iodides and bromides in the film are converted into the respective silver salts. If such a plate be exposed to light in a camera, for example, when copying a drawing, and the plate examined in the dark room, no visible change will be noticed.

But if we pour a solution of sulphate of iron in water upon it the silver will be precipitated, and changed to the metallic state upon those parts where the light has acted. Upon washing and applying a solution of cyanide of potassium, the parts unaffected by light will be dissolved away, leaving the drawing on the plate in clear transparent lines. For the reproduction of line work a diluted developer is used.

Saturated solution sulphate of iron	4 ounces
Acetic acid, No. 8	4 ounces
Water	20 ounces
Alcohol	1 ounce
Saturated solution sulphate of copper	½ ounce

First prepare the saturated solutions of iron and copper, which can be made in large quantities and kept for immediate use. Put the water in a bottle, add the saturated solution of iron, then in turn the acid, saturated sulphate of copper, and alcohol, shaking well after each addition.

Fixing.

In order to prevent further action of light and to make it transparent the plate is flowed with a solution of

Cyanide of potasium	1 ounce
Water	6 ounces

It dissolves the iodide and bromide of silver.

Cyanide fixing solution should be frequently changed as it becomes saturated with iodide of silver and deposits it in the plate, causing pin-holes.

Intensification.

All negatives copied from drawings suitable for photo-engraver's use must be intensified, that is, strengthened. Otherwise a clean print could not be made.

After fixing and washing the negative is placed in a tray containing

No. 1.

Saturated solution of bichloride of mercury. By adding a little chloride of ammonium more mercury will dissolve and the solution becomes more saturated.

Water..... 5 ounces

No. 2.

Hydrosulphate of ammonium..... 1 ounce

The plate is allowed to remain in solution No. 1 until it turns white. It is then removed and thoroughly washed and No. 2 poured over it. This at once forms a dense black deposit. The plate is now washed thoroughly, and the bluish-green color is removed by flowing with

Water 10 ounces
Nitric acid..... ¼ ounce

Varnishing.

When making negatives for the swelled gelatine process of engraving it is necessary to protect the film which would soon be ruined by mechanical injuries.

Dust the plate off carefully and apply a gum arabic solution in

Water..... 8 ounces
Gum arabic..... 1 ounce

Stripping Films.

In order to have the print appear correctly for zinc etching the film must be stripped from the glass and reversed. For this, two solutions are necessary, viz., rubber solution and collodion solution. The former is best prepared by taking pure washed rubber. This can be obtained of a dealer in rubber goods. Place it in a bottle and cover with about twice its weight of deodorized naptha and set aside for a few days, with

occasional stirring. The rubber will swell to about five times its original size, and then dissolve. This solution should be thinned to the consistency of castor oil and filtered. The collodion solution is prepared as follows:

Alcohol	4 ounces
Ether	5 ounces
Gun cotton	45 grains
Castor oil	½ dram

The cotton is dissolved in alcohol and ether, the oil added and shaken thoroughly. Set aside for a few days to settle and decant for use.

After all the chemicals have been prepared as described in the foregoing, photographic manipulations may be tried.

Before commencing, however, see that nothing has been overlooked. Be sure the collodion has settled enough so as to appear perfectly clear.

Cleaning the Negative Glass.

The cleaning is an operation which has to be performed with skill and care. The plates are first allowed to soak several days in a strong solution of caustic potash (common lye). They are next washed well with water until all trace of the lye has been removed. After each plate has been washed it is placed in acid solution.

Water	40 ounces
Crude nitric acid, 38 deg	8 ounces

The plates are allowed to remain in the solution two or three hours, when they are removed, washed well, and placed in a tray containing distilled water, and allowed to remain there for one or two hours. Take out, place on a negative rack to dry, and polish with Joseph paper. When clean, the edges of the plates are covered with an albumen solution.

Albumen	(the white of one egg)
Water	80 ounces
Concentrated liquid ammonia	5 or 6 drops

The albumen is placed in a clean bottle with a few pieces of broken glass, and it is shaken to a froth. Add the water and

ammonia, let settle two or three hours and filter. The edges should be covered to about one-quarter of an inch. Apply with a small tuft of filtering cotton. Place on rack to dry. Any number of plates may be thus prepared and stored away for use.

In place of the albumen solution the rubber stripping solution may be used, thinned down a little.

The above operation makes the collodion film adhere to the glass and prevents it from washing off in the subsequent operations.

Collodionizing.

To properly coat a glass plate with an even film of collodion requires considerable practice and patience. The glass plate, Fig. 28, should be held with the left hand in a horizontal position by the lower left hand corner D.

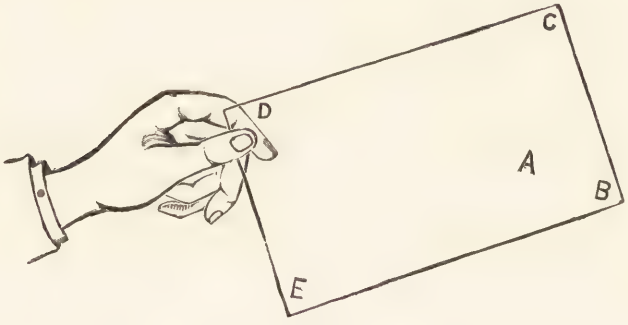


Fig. 28

Enough collodion is poured on at A, that is thought sufficient to just cover the plate. Gently incline the plate, allowing the collodion to run up in the corner at B, next to C, then to D, and finally to E. The plate is again inclined, allowing it to run to the corner B, and so on as first described until it again reaches the corner at E. This time the excess of collodion is allowed to run off gently into the collodion bottle held at E.

The plate is now gradually returned to a vertical position with a slow rocking motion. This will prevent the collodion

from drying in streaks. If by accident the collodion should run over the edge of the plate and on to the back it should be removed, keeping the plate constantly in motion and in a vertical position. The collodion should not touch the fingers, as it is liable to cause streaks in the picture.

When the lower corner where the collodion was allowed to run off has dried so as to leave an impression of the thumb, it should immediately be placed in the silver bath.

The coating of large plates by hand is somewhat more difficult. They are best supported in the centre by a tall corked bottle. When the collodion has been poured on, the bottle can be set down and both hands used in balancing the plate.

The Sensitizing.

By placing the collodionized plate into the silver bath it is made sensitive to light, the salts of iodine and bromine being converted into iodide and bromide of silver. The plate is lowered with steady motion into the bath by means of a dipper. When the plate has become submerged, it is moved around several times in circular motion, to aid the bath in mixing with the collodion. The plate should remain in the bath about five minutes, or when taken out and examined it should present an even surface. If, however, the surface appears greasy, similar to when pouring water over a greased surface, it has not become sufficiently sensitized and should be returned to the bath.

When the plate is removed raise it up far enough to catch hold of one corner. Allow the surplus solution to drip back into the holder, and place on a piece of blotting paper and lean against the wall; while the plate is draining wipe off the back with a squeegee, and place pieces of blotting paper on the lower glass corners of the plate holder. The plate is next placed in the plate holder, resting on blotting paper. This will catch any remaining solution that might run off and produce stains. Eventually, when properly adjusted, close the door of the plate holder. These operations must all be performed in the dark room by non-actinic light.

The Exposure.

The question of how long to expose can only be ascertained by actual experience. The time of exposure depends on the condition of your chemicals, power of light, capability of lens, diameter of stops, etc. In warm weather the collodion on the plate will dry very rapidly and will keep moist only for a short time. This may be prevented by placing a sheet of dark blotting paper saturated with water on the back of a plate. Another way, and perhaps the best for very long exposures, is to add glycerine chemically pure to the silver bath. About one ounce to the gallon. Plates thus treated withstand at least one hour's exposure if sufficient glycerine be added. (Glycerine added to a silver bath acidulated with nitric acid is very apt to decompose it, and when glycerine is at all used, it is better to substitute glacial acetic for the nitric acid.)

Development.

The exposed plate is carried to the dark room and removed from the plate holder, keeping it in the same vertical position as when first lowered into the silver bath. Take hold of the left-hand corner that was topmost in the holder, the same that was held when collodionizing. The developer bottle is taken hold of with the right hand. Place the rim of the wide-mouth bottle held with the left hand, Fig. 29, near the corner, and with a quick and sweeping motion, pour out its contents; tilt the plate at the same time, allowing the developer to flow evenly over the plate just enough to cover it. It should be poured out; it should not be dashed on too energetically, and should cover the entire plate in one even wave, and as little solution allowed to run off as possible.

If properly exposed, as soon as the developer covers the plate the picture becomes visible. The high lights being developed first and each successive shade in turn until the picture is formed. If the picture flashes out immediately the plate has been over-exposed. If too slow, it is under-exposed.

The plate should be constantly rocked, keeping the solution in motion, and if necessary shaken vigorously to drive the developer into the film.

Experience only can teach us when the development has been carried far enough. When the development has gone far enough, immediately place the plate under a tap and wash off the developer, the back being washed with the hand.

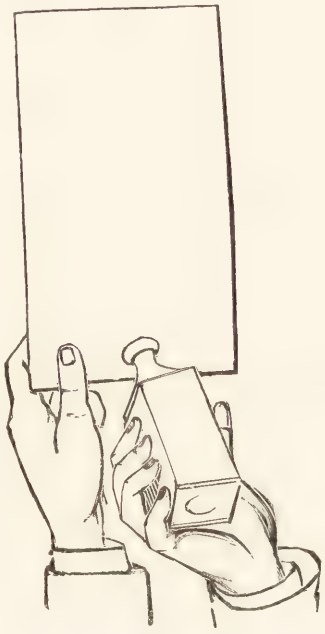


FIG. 29

If after examination the lines are found to be clear, transparent, sharp and free from spots, and all details of the copy are satisfactorily reproduced, the plate is ready for

FIXING.

After the plate has been developed it is fixed. The cyanide solution is poured off and on the plate, until its yellow color caused by iodide and bromide of silver has been taken off, and the plate has assumed a clear and transparent appearance, where light and developer has not acted.

Instead of pouring the fixing solution upon the developed and properly washed plate, many photographers prefer to dip

it in a bath dish containing the fixing solution and standing in a vertical or somewhat inclined position, in the same manner as the nitrate of silver bath.

Cyanide of potassium is very poisonous and must be handled with great care; inhalation of its fumes should be avoided as much as possible, especially in warm weather.

After fixing, the plate is thoroughly washed. The washing is deemed complete when the cyanide cannot be tasted by applying the tongue to the film. The smallest quantity of cyanide will indicate itself by imparting a bitter taste to the water.

The Intensification.

If we were to use the negative in its present condition, although sufficient for ordinary photographic work, it would be found impossible to make a print of it on zinc, for the purpose of being etched. To fit it for use it must be intensified, which is usually done with one of the metallic salts, bichloride of mercury producing the best effects.

The No. 1 solution is poured in a tray of convenient size, and into this the negative is placed. As soon as the plate is covered with the solution it turns black, and gradually assumes a lighter color, until finally it turns perfectly white. When this stage is reached the plate must be removed and washed in running water for at least fifteen minutes. Unless this is done, a portion of the mercury remaining on the plate will cause fog, closing up the finer lines, making the negative worthless.

If the negative is under-exposed and it does not bleach so as to produce sufficient intensity, wash well and flow with

Iodide of potassium	5 grains
Water	1 ounce

until it turns a yellow color. If it forms a dirty brown deposit the solution is too strong.

When the plate has become thoroughly washed allow it to drain and apply the No. 2 solution. This immediately turns the film an intense black perfectly opaque. It is allowed to remain on the plate until it has penetrated through the film, and is then washed off

By holding the plate up to the light and looking through it there will be found to be deposited over the film a greenish-blue tint. If the hydrosulphate is of an inferior quality this tint will be of a yellowish color and stain the plate, but if of the proper kind the tint will be removed by one application of No. 3.

The plate is now washed and placed on the negative rack to dry.

The Stripping.

As soon as the intensified plate becomes dry it is stripped from the glass and reversed.

This is generally deemed a very difficult task, but if carried out as here described will be found one of the easiest operations in the entire process.

The negative is held in the left hand and the No. 1 (rubber solution) is poured on in the same manner as described for flowing with collodion. In this case, however, the plate is not drained entirely of the solution, but the surplus only is returned to the bottle. If the solution has run over the edge and on to the back of the plate it is removed, the negative being laid face up on a level table to dry.

When perfectly dry the No. 2 (collodion) solution is applied, holding the plate as before, allowing just enough solution to run on the plate that will just cover it with some difficulty and coaxing. This should be done without having to pour any back into the bottle. The plate is again laid on the level table to dry. The film is cut through to the glass with a knife within a quarter of an inch of the picture on all sides, if the film is to be used without any support or use of printing frame. One corner of the film is started with the point of the knife blade, so as to be able to get a hold of it with the fingers, when it is easily removed. It is then laid aside on a piece of clean paper to dry more thoroughly. The film can now be placed on the zinc. The oil in the No. 2 solution acting as a paste will hold it fast. It should be smoothed down, care being taken to smooth out wrinkles, and remove all that may have gotten under it. If the film does not stick, not

enough oil has been added to the collodion, and more must be applied to the film. Pour a few drops of oil on a glass plate, and with a small rubber roller, distribute evenly. Lay the film on a piece of paper, and pass the charged roller over it, coating evenly. It will then be found to adhere perfectly well to the zinc. If the film is to be stripped back on the glass, after being cut around the edges, it is put into a tray containing clean water acidulated with acetic acid. The film will now begin to leave the plate. Before it has freed itself, remove entirely from the water, and squeegee on top of the film a piece of strong paper previously dampened until limpid. Catch hold of one corner of the paper, gently raise up and strip from the glass, care being taken that the film comes off with it. Lay the paper with the film on it, face up on the glass, from which it was removed, and place another piece of wet paper on it, squeegeeing as before. The papers are now separated and the films will be found to adhere to the paper last put on. All that now remains to be done is to place the sheet with the film to a clean glass, squeegee it well, remove the paper, and the operation is completed. This operation may seem a lot of work to some, but if tried will be found the easiest, quickest, and best way to strip a film.

CHAPTER V.

CAUSES OF FAILURE.—REMEDY AND CURE.

The Negative Bath.—The failures occurring with silver baths are manifold. When newly prepared they but rarely give satisfactory results at first trials, and when old many other difficulties will be found in its train. One change noticed in the bath is that the developer refuses to flow smoothly over the surface of the plate. The cause of this is that the bath contains alcohol and ether, which has accumulated from the collodion when sensitizing plates. The remedy for this is to add a little alcohol or a solution of gelatine in water to the developer. With the addition of either of the above an immediate mixture of the developer and the silver on the plate takes place and the developer flows evenly.

Filtering of the bath should be frequently done, say once a week. Remove the scum that forms on the surface with a piece of filtering paper each morning before using it. When the bath commences to yield thin bluish looking negatives, pinholes evenly distributed over the whole plate become visible, it is a good sign that the bath contains organic matter, or is surcharged with iodide of silver and needs rectifying. In such a case the bath is neutralized with conc. liq. ammonia, adding drop by drop of it at a time, with thorough shaking up after each addition, testing with red litmus paper and setting in the sun until clear, when it is filtered and reacidified. In bad weather, however, when the sun is not likely to benefit you, permanganate of potash may be added to the bath with success.

Permanganate of potash.....60 grains
Water..... 6 ounces

This solution is added to the bath one drop at a time, constantly stirring until the drops are no longer discolored and

the bath is of a pale violet color. Then expose in the sunlight. Permanganate of potash oxidizes the organic matter and deposits on the bottom of the vessel a black powder. As soon as clear the solution is filtered.

When the bath contains iodide of silver in excess, the plate will be covered with pinholes and spots evenly distributed, after development, all over. To remove the iodide of silver the bath must be poured into twice its volume of distilled water and well shaken. If the water had been added to the bath instead of the reverse, all of the iodide would have been precipitated. The bath is now filtered and poured into an evaporating dish and reduced to its former concentration by slowly evaporating over fire. The addition of a small amount of permanganate in this case also allows the iodides to separate more rapidly. Keep on hand three silver baths. One in present use, one in state of rectification, and the third rectified to good condition to be put at once to use when the first gives out.

Fog or a sort of mistiness over the negative is caused by the bath being alkaline or by organic substances in it.

Insensitiveness is caused by using too much acid in the bath. Make it less acid by adding a few drops conc. liq. ammonia. If the plate be lowered in to the bath before the collodion has set, it will have a ragged appearance, especially at the corner where allowed to run off. If the plate is allowed to stand too long after sensitizing, the film will have then insensitive spots near the top. Streaks in the direction the plate was dipped, is caused by removing from the bath before sufficiently sensitized. When the bath is not sufficiently iodized the plates look blue and thin.

Collodion.

An old red collodion is the best for reproduction of line work. It gives a heavier and denser film than when new. When it becomes too thick, dilute with new collodion of the same composition. It is recommended to use two collodion vials—one from which the collodion is poured, the other to pour the excess into which drains from the plate. When

this bottle becomes full, it is diluted if necessary, and filtered into the pouring bottle. The neck of the bottle should always be kept clean, or black spots on the plate will be the result. When a collodionized plate is placed into the bath too soon, the film becomes rotten and is easily injured. Newly iodized collodion should be allowed to settle, otherwise spots will manifest themselves. A few drops of tincture of iodine added to the collodion will prevent fog.

Exposure.

Unequal illumination causes unequal intensity. Pointing the lens directly towards the source of light, and when not otherwise protected, fog will ensue.

Want of sharpness is caused by careless focusing or by the camera being moved during exposure. In warm weather too long exposure and not allowing the plate to drain sufficiently causes marked spots, especially near the lower corner of the plate.

Development.

For the development of pictures in line, old, partly oxidized and reddish solution works well. When the developer is repelled by the film the bath contains alcohol and ether; to remedy add alcohol to the developer. Thin transparent spots appear where the developer is poured on the plate, because it has been poured on with such force as to wash away the nitrate of silver. Too little acid in the developer causes fog also.

Intensifying.

Fog is caused by not sufficiently washing the plate before applying the No. 2 intensifier, and because the hydrosulphate of ammonium has become too old and is decomposed. Unequal intensity is the result of not allowing the plate to drain long enough before using No. 2 solution. Insufficient intensity is the result of removing the plate from No. 1 solution, before it has become white.

Fixing.

The cyanide fixing solution is best kept in a bath holder, lowering the plates into the solution the same as when sensi-

tizing. It should be occasionally strengthened by the addition of a small lump of cyanide. If the film looks thin and transparent after fixing the solution is too strong.

Drying.

The film tears from the plate when drying because dirty glass has been used, or the plate has been intensified too long, or over-exposed, or the bath is too alkaline. The best remedy is to flow the plate with albumen after intensifying.

Stripping.

The stripping solution should never be applied until the plate has become thoroughly dry from preceding operations. The film adheres to the glass and tears when stripping because it was allowed to set too long before flowing with No. 1, or too long after flowing with No. 2. Remedy, moisten by wiping with a damp sponge, or allowing damp blotting paper to lay on it four or five minutes. The film has a tendency to curl when not enough oil has been added to the collodion. This can be prevented by dampening before stripping, and drying between unsized paper and under light pressure, as between the leaves of a book.

CHAPTER VI.

THE HALF-TONE PROCESS.—SCREEN PLATES.

Negatives for half-tone work are made precisely as described in the foregoing for line work, with the exception of a ruled plate, called a screen, being placed in front of the sensitized plate.

These screen plates are parallel lined and cross lined or dotted, being ruled in various widths of lines or dots from 120 to 240 lines to the inch, according to the class of work to be used for.

The best screen plates are made by coating a plate glass with collodion or other suitable ground. The plate is ruled with an ordinary wood engraver's ruling machine, cutting through the film to the glass. Since there has been such a demand for screen plates, several machines have been constructed in this country, especially for the ruling of them, by automatic action.

There is no difficulty in buying screen plates of any desired size or style at a very moderate cost, compared to the expense of making an original.

Lately these plates have been produced by coating a bevelled glass plate with a mixture of rubber dissolved in turpentine, adding to it, an equal amount of asphalt undissolved in turpentine. The plate is coated evenly and allowed to dry. It is then ruled with a wood engraver's machine, and etched with hydrofluoric acid for about two minutes. The coating is now cleaned off, and the lines filled with ink. When the ink has become dry, it is ready for use.

Plates produced in this manner are superior to others to a certain extent. The dots and lines are more transparent, being perfectly clear glass, and if stained with silver solution, they can be washed, whereas if collodion or gelatine plates become stained or scratched, they are useless.

Plates used in this country are made in various styles, the

most popular being the line plates, 1, 1, fig. 30, two screen plates being necessary for the production of negatives as will be described farther on.

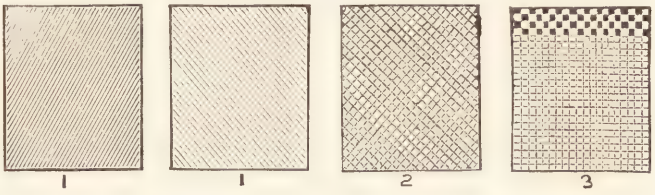


FIG. 30

Another style is a combination of 1, 150 lines to the inch, on one plate, 2, fig 30. Still another has dots on it, arranged like a checker board, only the corners are more rounded; the latter is very extensively used, and gives good results.

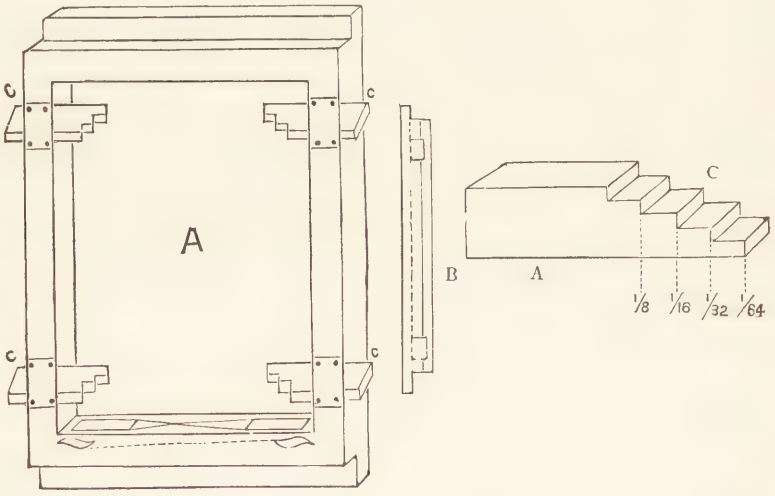


FIG. 31

THE KIT FOR THE HALF-TONE WORK.

Kits for this class of work are slightly different from the ordinary kind, but the plate holder remains the same. The kits are constructed so as to hold two plates instead of one, fig. 31.

A shows the side of the frame intended to receive the screen plate, being held in place by the springs in each corner, resting against the shields at a proper distance from the sensitized plate. The bearers C, which are of shellaced wood, four in number, are made to slide in a slot made for their reception. The flat side being on a plain with the grooves at the top and bottom. The bottom piece of the frame is hollowed to form a trough in which to catch the silver solution as it drains from the plate which rests on two silver wires.

B shows a side view, the dotted line represents the sensitive plate, and the solid line the screen plate. The bearers, C, are made with graduated steps, four in number, running from one eighth to one sixty-fourth of an inch.

Operation in Making Half-Tone Negatives.

When examining a photo-engraving made from several photographs, for instance, a portrait tableau, all on one plate, it will be seen frequently that some individual pictures are much better than others, that is, they contain more detail. Supposing the light pictures were the best, the darker ones being inferior, wanting in detail, the reason that the former are good can only be explained by the fact that the screen plate has been in proper position when exposure was made. To make an engraving as above described, and have each individual portrait equally good, is an impossibility.

To reproduce the correct colors of a photograph, the two plates must be a certain distance apart. As you know, the light portions of a photograph reflect more light than the darker, it is evident that the plates when copying a light picture, must be farther apart than when copying a darker one. The reflected light from the darker portions of the picture becoming diffused sooner than from the lighter, therefore, in order to get details from a dark picture, screen and sensitized plate must be closer together. You can now see why all the portraits did not reproduce with equally good results, the plate being separated the right distance from the sensitive plate the lighter pictures were correctly reproduced as to color and detail, while on the other hand, the plates were

too far apart for the proper reproduction of the darker portrait, the light reflected becoming weak and diffused before it reached the sensitive plate, and not acting long enough to get details.

From the above explanation, it is evident that when copying pictures of different color, the plates must be the proper distance apart, close together for the dark, and wider apart for the lighter ones.

Operating the Single Line Plates.

The first thing necessary is to study your copy for color, After determining on the distance the plates should be apart; adjust your bearers, lay in one of the screen plates, face down. See that the bearers are close against the plate, then set the springs in plates so as to prevent the plate from moving. The kit is now firmly fastened in the plate holder. Select a level negative glass, collodionized and sensitized the same as for line work. While the plate is sensitizing, tack the photograph on the copy board, and focus; when the plate has become sensitized remove from the bath, and allow it to stand on blotting paper, resting against the wall, removing the surplus solution from the back with a piece of blotter or a squeegee. The plate is then placed in position in the plate holder, and the door closed. It is then inserted in the camera. Unless your plate holder fits snugly to the camera, so that it can be taken out and replaced in exactly the same position, brass strips will have to be placed on one side, and the top of the camera, so as to guide the holder to the same place each time.

The exposure is now made, giving about three quarters the time that it would take to complete the exposure.

If the plate was developed at this stage, it would be flat and without life. The lines being wider in the parts that represent the high lights, than those that designate the dark portions. After the first exposure is made, remove the holder from the camera, and take it to the dark room. Lean against the wall with the slide next to you. Pull out the slide and remove the screen plate No. 1 and insert in its place No. 2, care being taken not to move the kit, and have the

ruled side of the screen next to the sensitized plate. Plate holder is again inserted in the camera, and placed in exactly the same position as at first. The exposure is now completed and taken to the dark-room, developed, fixed and intensified the same as for line work. By closely examining the plate, the second exposure will be found to have acted on those parts of the plate that represent the lightest colors in the photograph, giving it life. If the plates have been properly separated and the exposure has been correct, those parts that are the lightest on the copy will be represented in the negative by a small transparent dot, scarcely visible to the naked eye. As the color begins to change to the darker parts, the dots increase in size accordingly until they run into the darkest parts, when they disappear entirely.

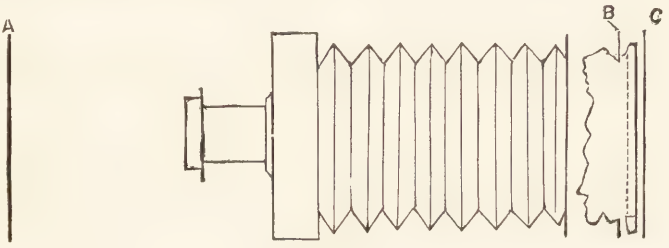


FIG. 32

In fig. 32 is shown the position the plates are in while the exposure is being made. A represents the copy, the dotted line B is the screen plate and the solid line C is the sensitized plate.

OPERATING CROSS LINED OR STIPPLE PLATES.

The operations are carried through with the cross lined plates, as with the single lined, with the exception that the negative is completed with one exposure. With these plates the same appearance of the finished engraving is always the same, while with single lines different colors can be produced by varying the two exposures.

The correct exposure can only be ascertained by experience and careful study of a copy. It generally takes one half longer than when copying direct without the screen interposed.

Cause of Failure in Making Half-Tone Negatives.

Want of detail is caused by not properly separating the plates, or insufficient exposure. When copying a dark picture, if the plates are too far apart, an extra long exposure will be necessary to bring out the details in the darkest part. This will result in spoiling the negative, and by the time the darker parts have received long enough exposure to bring them out, the high lights will have spread so much as to cause them to fill up and blur. The greatest trouble, however, is when sufficient exposure is not given. A good, full exposure is necessary to make a first-class negative, and to get all details. If black spots present themselves on the negative, see if there is not a scratch on the screen plate that corresponds with it, or if the spots on the negative are transparent, it is caused from silver stains or dust on the screen.

CHAPTER VII.

ZINC ETCHING.

Preparation of Chemicals used in Zinc Etching—Albumen Sensitizing Solution.

The solution used for printing on zinc for ordinary work is a sensitized albumen solution.

Albumen	white of 1 egg
Water	8 ounces
Bichromate of ammonium	15 grains

The albumen is placed in a bottle containing pieces of clean glass. It is then shaken until the albumen comes to a froth, then add the water and shake well again. The bichromate is put into a mortar and ground to a powder, adding enough water to dissolve it, then add to the albumen, shake well, and add a few drops concentrated liquor of ammonia, just enough to change to a clear yellow color. The solution is shaken again when it is set aside to settle. It is then filtered. Place the mouth of a funnel in contact with the mouth of the bottle so as to allow the solution to run down the side of the bottle, thus preventing air bubbles from forming, which, when present, cause much annoyance when coating the zinc plate. Albumen should be prepared the day before using.

Asphaltum or Bitumen Sensitizing Solution.

This solution is used for the finest grade of work, especially half-tone. It is not as sensitive to light as the albumen solution. It takes from three to four times the exposure and is much more expensive.

This solution is a preparation made from that portion of asphaltum which is sensitive to light, the part soluble in ether being insensitive.

To prepare put into a wide-mouthed bottle a sufficient quantity of the best Syrian asphaltum and cover with about

twice its bulk of oil of turpentine. Set aside for three or four days with occasional stirring until the turpentine becomes saturated with soluble bitumen. When the turpentine has been saturated pour into another bottle and add to it concentrated sulphuric ether, little by little, with constant stirring in conformity to the bulk of the bottle.

The addition of the ether precipitates that portion of the asphaltum not soluble in ether. The portion soluble in ether remains in solution.

After all the ether has been added, it is allowed to stand over-night, when it is tested to find whether all of the bitumen insoluble in ether has been precipitated. This is done by pouring a small quantity into a bottle and adding more ether to it. If a precipitate manifests itself it is evident that enough ether has not been added. After standing two or three hours test again.

The liquid is now poured off into another bottle; to the precipitated portion that remains fresh ether is added, which takes up the remaining soluble asphaltum and turpentine. Stir up well during the day, allow to settle, and pour off the ether, draining closely. Ether is once more added, and stirred well, and poured into a coarse muslin filter. What remains on the muslin filter is spread out on clean paper, and allowed to dry until the ether has entirely evaporated. It is then powdered. To one ounce of the powder add sixteen ounces of pure benzole, free from water. Dissolve and filter through filtering paper.

If, when printing, the bitumen has a tendency to crack or peel from the plate, add a few drops of Venice turpentine.

Zinc Print Developer.

If, when printing on zinc with the albumen solution the print has been slightly over-exposed, the ink adheres to the zinc in places, and has a dirty appearance, the addition of a few drops of the following solution will remove these objections.

Saturated solution bichromate of ammonium.....7 ounces
Conc. liq. ammonium.....1 ounce

Etching Powder.

The very best etching powder obtainable is the finest grade of Dragon's blood. As there are several grades of this powder, great care should be taken in its selection. The best grade is of a deep vermilion color, and not so light and fluffy as inferior grades.

Gum Solution.

Gum solution is used to prevent the inks from adhering to the zinc when rolling up. It is best prepared by taking a sufficient quantity of gum arabic, and putting in a clean bottle and dissolving. By setting in the sun or a warm place it dissolves much quicker. If strong heat be used to dissolve it the solution soon sours.

To 12 ounces of the gum solution, which must be about as thick as castor oil, add ½ ounce of phosphoric acid.

Etching Ink.

To prepare etching ink and do it properly requires some experience. It is recommended to buy it ready prepared, but those who desire to make their own will find the below receipt all that is desired:

White beeswax	6 ounces
White soap	2 ounces
Shellac	2 ounces
Lithographic ink	3 ounces
Middle varnish	1 ounce

Melt together the wax and soap, and before they get hot add the lithographic ink and raise the heat a little; set fire to it and allow to burn twenty seconds, when the flame is extinguished by covering the vessel with a lid; add a little at a time the shellac, constantly stirring; heat again until the mass boils or takes fire, when it is removed, allowed to cool and pour upon a slab, rub in the middle varnish with muller until perfectly smooth and free from lumps, and then it is ready for use.

Ink thus made should be about the consistency of lithographic ink; if not, add middle varnish until of the proper

consistency. The above ink is used only for rolling up during etching. Lithographic transfer ink being used when rolling up after exposure.

Deep Etching Liquid.

For etching the wide spaces deeper a strong solution is prepared as follows:

Water	20 ounces
Muriatic acid	4 ounces
Nitric acid	2 ounces

Material and Apparatus used in Zinc Etching.

The properties of the metal when pure are characteristic. Commercial zinc is not pure and not fit for our purpose. It always contains carbon, arsenic, lead, cadmium or iron. When pure it is a bluish-white metal, crystalline and brittle. Between a temperature of 200 and 300 deg. it is quite malleable, and can be rolled into sheets, hammered, or drawn into wire. Lead has a peculiar influence in diminishing the brittleness of zinc. Two parts of zinc and one of lead are not brittle (tin and zinc are hard), forming a very compact metal.

To refine zinc the crude metal is remelted in large iron pots lined with clay to prevent the adulteration of zinc with iron. The heat applied should be very moderate. The lowest heat and previously warmed moulds are required to make soft metal. In this operation volatile metals are evaporated, while oxides as those of iron rise to the surface and may be skimmed off. The metal is now cast in a mould. Zinc is rolled into sheets similar to iron. Plates about an inch thick are heated to a temperature about 250 deg. and put between rollers, which are also heated and greased with oil. During the rolling the zinc should undergo no change in temperature; when rolled to the right thickness they are cooled slowly in an oven. The thickness of zinc used in photo-engraving generally is one-sixteenth and one-eighth of an inch.

Zinc Hooks.

In establishments not having power saws, a tool called a hook, Fig. 33, is used to cut zinc into the required sizes for

use. It is far superior to the hand saw, cutting quicker and without danger of bending the zinc out of shape. They are best made out of an old file by bending into a V-shaped edge

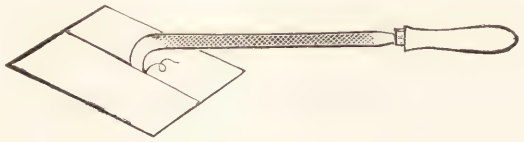


Fig. 33

similar to a lozenge graver. The teeth of this file can be left unchanged and be used to smooth the sharp edge left on the zinc after cutting, thus having two tools in one.

Gas Oven.

Large gas ovens used to heat the zinc during etching are the best; with them an even temperature over the entire plate is maintained throughout. Small burners sometimes used are worthless whenever a very large plate is to be etched. The plate has to be made warm on one side and then be changed to the other. In small ovens it is impossible to get an even heat over the entire plate, which is absolutely necessary. In the larger-sized furnaces a greater amount of gas is consumed, but the superiority of them over the smaller ones is so great that it is recommended to use them. The size of these furnaces is about 18 inches square. They are heated with nine or ten Bunsen burners and covered with a sheet-iron hood to confine

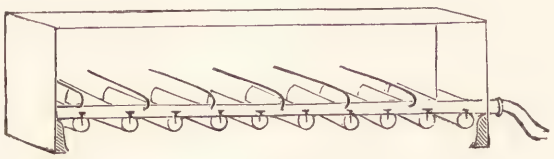


Fig. 34

the heat. The top of the furnace can be covered with a sheet of tin plate if desired. Two inches above the heaters and across the furnace wires are suspended by cross-pieces. Upon

these the plate is laid. By this arrangement the zinc is kept from warping, which is always the case when held in the hand with pincers or laid on a flat piece of iron.

Etching Tub.

Etching tubs adapted for general work are of 18 x 24 inches in dimensions. They should be provided with a dash-board to prevent the bath from splashing out, and made so as to rock without much exertion, or run by steam power. The tub constructed on my plan, Fig. 35, has all conveniences. It is

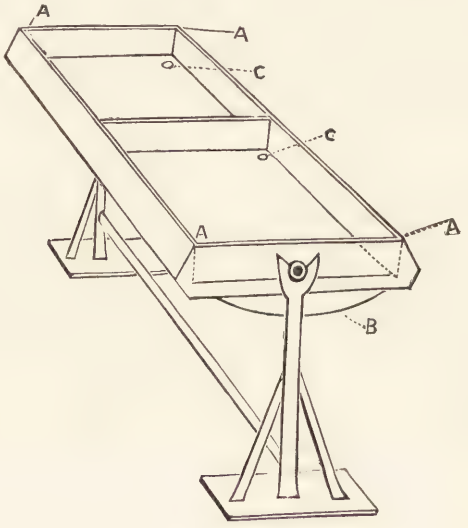


Fig. 35

provided with dash-boards, AA, springs, B, which regulates the swing of the tub, and draining holes, CC.

Printing Frame.

The common printing frame as used by photographers is not suitable for printing on zinc, as enough pressure cannot be obtained. I have used several frames of different construction, none of them giving satisfaction, the greatest fault being that enough pressure could not be obtained without breaking the frame or glass.

The frame, fig. 36, is the best in use, being heavily constructed and having one inch plate glass and wood screens.

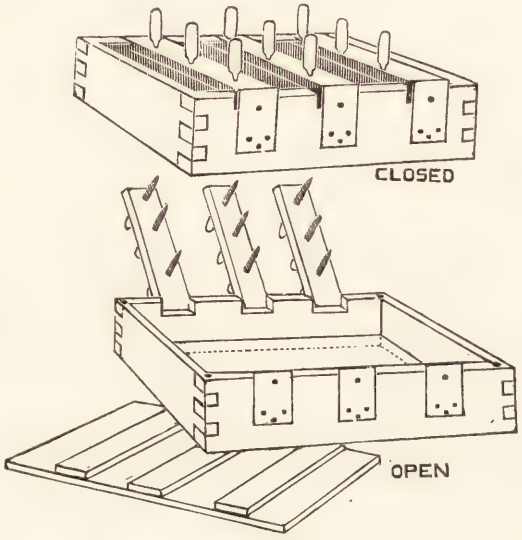


FIG. 36

The pressure is applied by iron thumb-screws that press against the top board, which is covered with heavy sheet iron.

CALLIPERS.

The best of zinc has low places and small holes on its surface caused from dirt falling on the zinc when rolling. These have to be punched level with the face of the zinc with a nail-set or punch from the back of the plate. In order to locate these dents a pair of callipers, fig 37, are required.



FIG. 37

By placing one of the sharp points in the dent and squeezing together the calliper makes a small impression directly opposite on the back of the zinc marking the point to be punched up.

Pliers.

In order to grip the zinc more firmly special pliers are used, being about the same size and construction as the ordinary ones, only having an extra wide nose.

Lithographic Rollers.

These rollers are of two kinds, one having a smooth surface, the other rough. They are made by covering a round wooden roller with leather and placed in a lathe and the surface finished off. This makes a smooth roller. The rough ones are scraped with a knife until their surface has a rough and ragged appearance.

To prepare before use they are rolled up in castor oil and No. 2 Litho varnish four or five hours until the leather becomes somewhat softer and has more suction. The older rollers are, the more valuable they become, if regularly used and well taken care of.

Hand Rest.

In order to rest the hand and protect the print on the zinc, when touching up, a hand rest (Fig. 38) or bridge is used. It

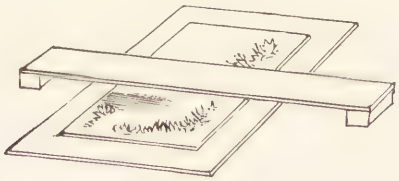


Fig. 38

is made by nailing a block on each end of a strip of wood about three inches wide and of a suitable length.

Buffer.

In order to get better results and save time in polishing zinc an apparatus to be run by power constructed on the plan as shown in Fig. 39 will give good results.

The zinc, A, is placed on a bed, B, which runs on a track

leading under the buff-wheel, C, which is made removable, so that it can be replaced with buffs of different surfaces. Thus the first is covered with leather, using emery powder; another

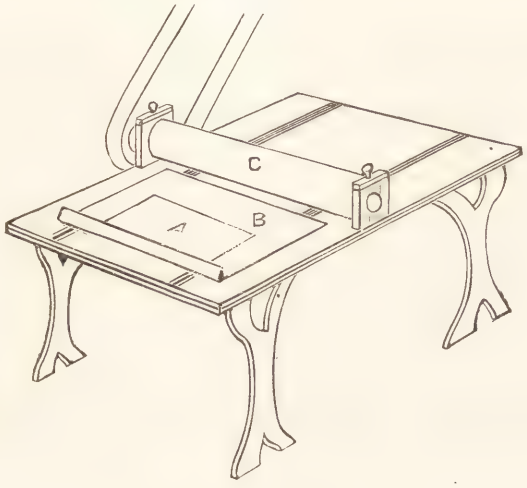


FIG. 39

covered with ducking, using rouge or other suitable polishing material. The last one used being ducking buffs cut around about eight inches in diameter with a hole in the centre large enough to fit on a mandrel similar to a circular saw.

ETCHING BRUSH.

The ordinary brush without protection against the acid would soon become corroded and useless. To avoid this, the brush, which is a common flat bristle varnish, is bound with tin. This is coated several times with asphaltum varnish allowing the bristles for about a quarter of an inch from the tin to take up a good supply. When thoroughly dry it is fit for use.

OPERATIONS IN ZINC ETCHING.—CUTTING THE ZINC.

After selecting the gauge of zinc required, place it on the cutting table and measure off the size, making it about three-quarters of an inch larger on all sides than the design. This allows sufficient room to handle when etching. Lay a straight-

edge to correspond with the chalk marks, and with the zinc hook draw across the plate using the straight-edge for a guide. When a small line has been cut by removing the straight-edge both hands may be used. Cut deep enough to break the zinc off without bending. The rough edge left in cutting is removed with a file. It is then ready to be polished.

Preparing the Zinc Before Polishing.

Before polishing the zinc any kinks or low places must be made even. If twisted out of shape and it cannot easily be made level on account of the zinc being too stiff, heat it several times, allowing to cool slowly. It can then be flattened out by laying on a level iron block beating it down with a raw-hide mallet. The holes are leveled up by locating the point on the opposite side of the zinc with a pair of callipers; lay the zinc face down on a smooth iron plate and with a punch lightly beat up until level. The plate is gone over in this manner until perfectly flat and all holes are leveled up.

Polishing the Zinc.

The prepared zinc plate is laid on the polishing stand. This is a four-legged stand having a top inclining to an angle of about 20 degrees covered with thin zinc, and should be about one inch deep with a drain hole in the lower corner.

Commence polishing with levigated pumice-stone previously soaked in water, rubbing with an up-and-down motion in a direction with the grain of the zinc. Do not, under any circumstances, rub in circular motions.

The pumice-stone should be used until all waves, if any, and the entire top surface of the zinc, have been removed. The plate is now washed and next polished with rotten-stone, using plenty of water and moderate pressure. This stone has a fine grain and takes hold of the zinc nicely, soon cutting away the rough surface left by the pumice-stone. When the deep scratches and rough appearance has been removed wash and polish with fine grained willow charcoal previously soaked in water. The polishing should be continued with the charcoal

until perfectly smooth and bright enough to reflect. The zinc is now washed well with clean water and set aside to dry.

Sensitizing the Zinc with Albumen.

Before sensitizing the zinc it should be polished with powdered charcoal and whiting to remove the oxide from its surface. Then immediately place under the tap and wash well; drain and flow with a dilute solution of ammonia:

Water	5 ounces.
Conc. liq. ammonia	1 "

drain well and pour on the sensitizing solution which has been well filtered. Hold the mouth of the bottle close to the zinc to prevent air bells from forming. This operation should be performed similar to collodionizing, allowing the solution to run off into the sink. Apply again, going through the same operations, draining well. Then hold at an angle of about 20 degrees over a Bunsen burner or coal-oil stove removing the solution with a piece of blotter as it sets at the bottom of the plate. Allow the heat to strike the top of the plate first, gradually moving forward as the plate dries. Do not try to dry too rapidly; the slower the better. The zinc should not be made hotter than the hands can bear with comfort. With beginners the plate is generally made too hot by which the albumen is coagulated or the coating is heavier at the bottom than at the top. Practice and careful study is the only means of properly sensitizing a plate.

The Exposure.

When the plate has become cool the negative is placed face up in the printing frame, care being taken that there is no dirt or grit upon the glass of the frame, otherwise the negative is liable to be fractured when the pressure is applied.

The sensitized zinc is now laid face down upon the negative; do not shift around after the plates are in contact otherwise the negative is liable to become scratched. Place the top board in the frame; a sheet of india-rubber about one-eighth of an inch thick placed next to the zinc greatly aids in getting

contact, especially when working a large plate. The top is next placed in its position and the pressure applied by tightening the screws, each a little at a time, the ones immediately over the plates. If by looking at the negative the zinc can be plainly seen through the lines of the negative the pressure is sufficient, but if sharp at places and dull at others apply more pressure at points needing it. The plate is now exposed. If you are working with a strong negative it can be placed in strong light; if weak it should be exposed in diffused light. The time of exposure, whether to sun or electric light will of course depend on the strength of such light, but will vary from one to fifteen minutes (or more). In direct sunlight about six minutes, and with a powerful electric arc light about twenty. The correct time can only be ascertained by experience. An instrument called the actinometer—described in another chapter—will be found useful in timing exposures.

The Rolling Up.

After exposure, remove the frame to its place in the darkroom and remove the zinc plate, which is then to be coated with a thin layer of ink. A small piece of lithographic transfer ink, about the size of a hickory nut, is placed upon the ink slab and sprinkled with a few drops of oil of turpentine and worked with the ink knife until dissolved. Proceed to roll vigorously with a smooth-faced lithographic roller previously prepared. Continue rolling and distributing the ink well over the slab until the turpentine has evaporated and the roller seems to take up very little ink. The zinc plate is now laid face up on the end of the slab; proceed to roll up. The ink does not adhere to the zinc at first, but by continually rolling from all sides a thin, even coating will be the result. Enough ink should be applied to just distinguish the yellow color of the sensitizing solution on the zinc. Set aside to allow any turpentine that may be in the ink to evaporate and prepare for

The Development.

The inked plate is now placed in a tray containing clear, cool water, deep enough to just cover the plate. Rock a few

moments to allow the water to penetrate the ink. Now take a small amount of filtering cotton, gently rub with a circular motion; if properly exposed the ink covering the parts not acted on by light will be washed away leaving the parts acted on by the light in strong black lines (the print). If the ink does not leave the plate clean on all parts remove the zinc from the water and lay on the table, keeping the surface well moistened, add a few drops of albumen print developer to the water in the tray and mix. Now dip a tuft of cotton in this and rub the affected parts of the prints; unless a very bad case this remedy will remove the fault immediately.

If upon developing the lines smear, too much oil is in the ink or the water is too warm. If the ink is removed from the entire surface with difficulty it has been over-exposed, whereas if only certain parts cannot be developed the zinc was not in contact with the negative. The lines will be washed away entirely, especially the finer ones when under-exposed. If the print is satisfactorily developed, wash and dry by patting gently with a damp linen rag free from lint, or chamois skin.

The Etching.

It is presumed that the chemicals and apparatus are properly prepared and arranged in convenient manner. Place enough water in the etching tub to cover the zinc plate, and add a few drops of nitric acid 380 deg. Enough should be added to just be susceptible to the taste. Place the plate in the tray and rock gently for thirty seconds, no longer. Remove and wash well in clear running water, drain and blot with a damp chamois skin and dry with gentle heat. The print is now examined. If any lines are broken or additions are to be made, it is done with a camel-hair brush dipped in lithographic transfer ink thinned with turpentine to the consistency of thick paint. The wide open spaces between the lines are also painted, as in Fig. 40, to within one-quarter of an inch from the lines. The margin of the picture should be gone around in the same manner.

Powdering.

Etching powder is now applied to the print by holding the plate on the edge with both hands, holding in a perpendicular position, scrape the edge which was nearest to you on the bottom of the box, carrying the powder in front of it to the side of the box, when the plate is slightly raised and turned half over, allowing the powder which was scraped up on the edge



Fig. 40

of the plate to fall over the entire print and then off into the box again. Now dust off the surplus powder with a soft felt brush—what is known as fitch-flowing is the best. With a flat camel-hair brush remove the remaining fine powder, dusting well in all directions. The plate is next heated just enough to melt the powder so as to unite with the ink. This is determined by the plate turning from a brown to black color. When sufficiently heated remove and allow to cool by placing on a lithographic stone or wipe the back with a wet sponge. If thought necessary the powdering can be repeated again. If there is too much heat applied at this stage the ink

will melt and spread, causing the finer details to close up. Great care should be taken not to heat the plate hotter than is necessary to melt the powder.

The back and edges of the plate are now painted with shellac and varnish and allowed to dry.

The First Etching.

A small amount of nitric acid is added to the etching bath. The exact amount necessary is best learned by experience. However, it should not be stronger than vinegar to the taste. It is better to add a few drops at a time, just as much as the plate requires, than to measure off a specified amount to add to the bath each time. Place the plate in the tub and rock gently. If the bath is made so strong as to form small bubbles on the plate, it must be removed and washed, diluting the bath with water. To determine whether the bath is strong enough, let the tub stand still, keeping the plate submerged for about one minute, then with the finger draw over the zinc. If a bright spot is made by so doing, it shows that the bath contains enough acid, as the oxide formed was wiped away, leaving the zinc bright, same as drawing the finger across a dusty table. After the plate has been in the bath a short time it will turn a dark color, caused by the acid attacking the zinc. The result is oxide of zinc and must be brushed away when formed, which allows the acid to work more freely and cleaner. Do not brush so hard as to injure the print. Watch the plate carefully, especially the fine lines and dots. If they show signs of getting weak remove the plate and wash well. The first etching should be carried as far as possible without running the risk of losing lines. The depth is generally about the thickness of light cardboard. The depth is ascertained by catching on the margin with the finger nail.

The time necessary to complete the first etching will be from five to ten minutes. Coarse open work can be etched longer than the finer grades. When it is judged that the plate has been etched as long as it will stand, brush well, remove and wash under the tap. Carefully wipe with a damp rag and dry with gentle heat. To prepare the plate for the

second etching, if it is necessary to strengthen the print, roll up with etching ink as follows: The gum solution described under chemicals is applied to the plate with a soft sponge, wiping in all directions. Then squeeze the sponge nearly dry and go over the plate again to remove the surplus solution. Allow the gum to dry spontaneously or by fanning, heat should in no case be used. A lithographic roller with a smooth surface is used for rolling up and the etching ink, described in another chapter. Take a small amount of ink on the point of a knife and spread in a line across the roller from end to end; proceed to roll, distributing the ink over the stone. When the gum is dry dip the sponge in a solution—

Gum solution [as first used].....1 ounce
Water.....4 ounces

Squeeze out several times and go over the entire plate until moistened; do not make it too wet. Next roll up with the ink and roller, using moderate pressure and rather slow motion. The ink will not take readily at first, but with continual rolling and recharging of the roller with ink and keeping the plate moist the ink will gradually take hold until the image is an intense black. If the ink should adhere to the open spaces between the lines, immediately wipe off with the sponge which should always be kept well moistened with diluted gum solution. The plate being satisfactorily rolled up moisten the sponge, wipe gently over the surface of the plate removing any ink that may be on the white spaces, or that has formed on the lines, making them have a ragged appearance. Now wash well in running water and dry powder as at first, heat slightly and cool, it is then ready for the second etch. It is not necessary to roll up the plate unless it is very weak from too strong an etch or insufficient ink to protect the lines.

For the second etch the bath is made a little stronger than for the first and should be kept at about the same strength by small additions of acid until ready to be removed. Keep the tray rocking, removing from the zinc the oxide as it forms. The depth in the second etch should be about twice that of the first. Watch the plate for any signs of breaks in the lines or

undercutting. When the second etching is completed and the plate dried it is ready for the third.

This time the plate is powdered from all sides. Begin by powdering the same as described for the first etching, commencing at the top of the plate, Fig. 41. When sufficient

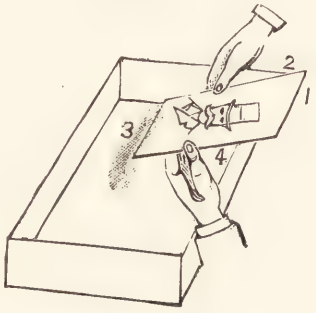


FIG. 41

powder has collected on the plate raise slightly and tilt the plate as shown in Fig. 41 allowing the powder to slide from the top of the plate at 1, covering its entire surface, letting the surplus fall back into the box. It will be found upon examination that the powder has been caught on the sides of the lines facing you, and which run parallel with the top of

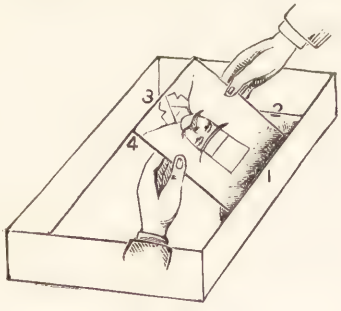


FIG. 42

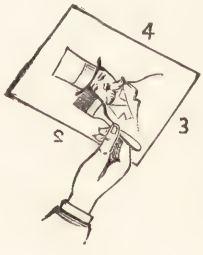


FIG. 43

the plate. The remaining surplus powder is now removed with brush No. 1, brushing in a straight line from the top of the plate, 1 to 3, Fig. 43. Next the camel-hair brush is used to make sure that no powder is left on the plate excepting what has been caught on the sides of the lines and absorbed by the

ink. The plate is now put in the oven and heated until the powder is melted which is detected by the coating changing to a dark color. It should be made hot enough to singe when touched with your damp finger. It is then removed, laid on the stone until cool, when it is powdered from another side, 2, Fig. 42, carrying it through the same course as described before, the remaining sides. Powdering, dusting with two brushes, heating and cooling.

It will be noticed that in powdering the finer details will become filled with powder which does not brush out; that is all right, as those parts are deep enough. The plate should be carefully watched through its entire course of etching for broken lines or undercutting; if detected, cover with the transfer ink and turpentine and powder. The plate is now given the third etch. Reinforce the etching bath with more nitric acid and etch as before, keeping about the strength of vinegar. The plate for this etch, as the same with each succeeding one, can be carried farther, as the lines have a better protection than during the first etch.

The same operations are carried on as described for the first, second and third etches until the plate is of sufficient depth. The inking up being done only when plate shows signs of becoming weak, generally once is enough, the powder producing all necessary resistance against the acid.

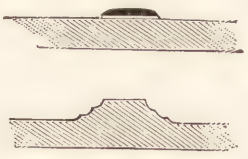


FIG. 44

To get the best results from the gum solution it should always be fresh. If used when sour the plate is sure to be ruined by the ink sticking to the whites.

The heating of the plate after inking up or powdering should be carefully watched. If heated at too high a temperature the ink or powder melts or runs out on to the zinc making shoulders or steps as in Fig. 44. If not heated enough the

powder will not melt, being brushed away during powdering or washed away during etching, thus exposing the lines to the action of the acid.

If it should become advisable to ink up a second time it is not necessary to allow the gum to dry before applying the ink. Smear over first with the thick solution, then wipe off gently with the diluted solution.

Re-Etching.

When the plate has been etched deep enough to insure clean printing, the ink is thoroughly cleaned off by heating and brushing with a scrub-brush dipped in a strong solution of lye. Dry by placing in a box of dry sawdust rubbing well until clean. By examining the plate the sides of the lines will show a step or off-set where each was begun as in Fig. 44. If these steps are allowed to remain they would take ink in printing and make an impression that would mar the appearance of the print. Especially will this be the case in newspaper work, where heavy pressure is used. To remove the steps first roll up with etching ink using a lithographic roller, rolling in all directions and using but moderate pressure. Only enough ink should be used to make a thin coating on the face of the lines and not on the sides.

The plate is now powdered and dusted well from all sides; heat slightly, care being taken not to make so hot as to cause the ink to run.

When the plate is cool it is etched for one minute in an etching bath, which should be very weak. About the same strength as used for the first etch.

The time it should remain in this bath varies from five to ten minutes. The plate is now removed, washed, well dried and inked again and powdered, making the plate hotter this time and causing the ink to run slightly down the sides of the lines. Strengthen the bath slightly and etch again, continuing longer this time, about 15 minutes. The plate is now washed off with the lye solution and rinsed well. If the steps have been removed and the plate is all right otherwise, the wide open spaces are next routed out by machinery.

Deep Etching.

If you have no routing machine the best way would be to paint the entire plate with asphaltum varnish except those parts to be removed. Warm slightly and allow to dry. The plate is now put in the bath composed of

Water	5 ounces
Nitric acid	1 "

Rock the tray until the plate shows signs of weakening. It is then removed, dried, touched up, dried again, and placed in the bath.

These operations are continued until deep enough, when the plate is cleaned well, back as well as front. This etching is best done before the plate is cleaned for the re-etching, as then the lines can be better protected against the acid.



CHAPTER VIII.

ETCHING IN HALF-TONE.

The etching of half-tone engravings is done about the same as for line work.

If the print was made on bitumen it becomes much harder when exposed to light, and is less affected by the acid.

Prints in albumen are made for this process the same as for line work. When developing the image rub in one direction only, and examine with a magnifying glass to be sure it is developed clean. Carefully wipe off the water with a damp chamois skin and dry by gentle heat. The print is now powdered and brushed well, when it is again powdered with black-lead, the same grade as is used by electrotypers; brush off the surplus and clean the plate well with a tuft of filtering cotton.

Coat the back of the plate with shellac varnish, put the plate in the oven, and allow to remain until the powder changes to a darker color. Remove and allow to cool. It is then ready to be etched.

The acid bath must not be stronger than can be tasted, and etching must be done with more than usual care and attention.

Sensitizing Zinc with Bitumen.

Polish the zinc before sensitizing, same as when using the albumen solution.

On account of the benzole used in making the bitumen solution, which evaporates very rapidly, it is almost impossible to get an even coating unless very thick. By practice, however, it can be very satisfactorily done, operating the same as when collodionizing.

The solution should be well filtered through filtering paper before use. If the negative adheres to the bitumen too much Venice turpentine has been added. Brush the surface of the zinc with French chalk.

Any number of plates can be prepared at a time for future use, storing them in a dry place free from light.

When the plates are dry, place the negative in the printing frame film up. Upon this, place the sensitized plate, apply the pressure, and expose. The time of exposure will be from ten to twenty-five minutes in the sun, and one or two hours in diffused light.

It is preferable to have the plate fully exposed; if over-exposed, the print can be made to come out all right by longer development, while on the other hand, if under-exposed, the print will be lost.

After exposure the plate is developed by placing in a tray containing spirits of turpentine; rock the tray gently, watching the plate carefully. As soon as all the details are plainly visible remove and wash in a gentle stream of water. Upon examining the plate there will be seen a thin scum of bitumen solution. If the plate were left in this condition, clean etching would be impossible, but it is removed by saturating a tuft of absorbent cotton in turpentine, and gently wiping over the print until the scum has been removed. Wash the plate well in running water, then place the developed plate in a very weak bath of nitric acid in water just strong enough to taste. Allow the plate to remain until the grease has been removed. The plate is then immediately taken from the bath, washed and dried. After the scum and washing has been completed and the plate slightly heated, place the plate in the sun and allow to remain until ready to be etched. This hardens the asphaltum and effects a stronger resistance against the acid.

The Etching.

First coat the back of the plate with asphaltum varnish and allow to dry. Then place in the etching bath, which should be just strong enough to taste. The coating of bitumen should be heavy enough to complete with one etch; if not gum and ink up same as described for line work. Some difficulty will no doubt be encountered, as the bitumen will not take the ink as readily as the albumen film. During the

etching the fine dots in the high lights require the most attention. It will be necessary to use a magnifying glass in order to see them more plainly. If there are any signs of their being cut away remove the plate; if not deep enough it will be necessary to ink up and etch again.

Cause of Failure when Developing Half-tone Engraving.

If when developing the print the image is dissolved away the exposure has not been carried far enough. If the print does not develop at all, it has been over-exposed, or the sensitizing solution has not been properly made.

If when washing the plate after development the print washes away, the development has been carried too far.

If the negative sticks to the zinc plate when printing, and it is known that an excess of castor-oil is not in stripping collodion, it is a sure sign that too much Venice turpentine has been added to the sensitizing solution.

When printing with bitumen, if an over-exposure is made, the print can be made to develop easier by adding a few drops concentrated sulphuric ether to the developer.

If too much is added, it is liable to wash away the entire print.

Cause of Failure in Etching Half-tone Engravings.

If the finer details in the blacks are not etched out, the development of the plate was not carried far enough to allow perfect washing out of these parts, and a film of the sensitizing solution strong enough to resist the etching bath is left.

Should the plate require rolling up with ink before it has etched deep enough, the sensitive coating was not heavy enough or etching bath was too strong.

CHAPTER IX.

BLOCKING AND FINISHING.—TOOLS AND MATERIALS.

The majority of photo-engravers job out their routing and blocking to an electrotyper, which is about as economical as doing it yourself, unless enough work is on hand to keep two or three finishers busy.

As is often the case there being no electrotypers in some towns it becomes necessary to do your own work, so I will describe the manner of operating.

Routing Machine.

The most important of all machines necessary for blocking is the router. There are several machines in the market; the cheaper ones are not suitable for routing zinc. Buy the best possible and you will have no trouble.

The router consists of a heavy iron table supporting an iron post; from this swings an arm upon which a spindle revolves that holds the cutting knife. The arm is so arranged that it can be moved around so as to be placed at any point within its reach.

Circular Saw.

The circular saw does not need much description, as every one knows what they are. Those best adapted for finishers' work should have an iron table made to raise or lower by means of a screw, and also be provided with gauges.

Shoot-Board and Planes.

In order to make the block square and present a finished appearance the sides are planed. This is done with a shoot-board and plane. The board consists of a level iron plate with a groove on the side in which a heavy iron plane slides; on the end is a cross strip on an angle with the plane. Two

planes are generally sent with each board, one of them so arranged as to bevel the plate on the edge to admit of being nailed on the block, when there are no open spaces to drive in nails, such as with half-tone work. The other being the squaring plane tempered so as to stand cutting zinc.

The Trimmer.

In large establishments a trimmer is used to square the blocks instead of the shoot-boards and plane. As this machine runs by power more work can be turned out than with the shoot-board and planes. It consists of a spindle to which are attached two knives revolving 500 revolutions a minute on an angle with the knives, and a table slide which is provided with a gauge. The block is laid on the table, the gauge adjusted and slowly moved forward past the knives.

Jig Saw and Drill.

Any jig saw, whether foot or steam power, having a drill attachment and capable of cutting through a mounted block, will answer all requirements.

Blocking Wood.

The best blocking wood is mahogany, but as this is too expensive for general work, cherry or birch is used. It can be bought ready planed with a "Daniel's" planer any desired thickness, and generally two feet long.

Nails.

Small wire nails from one-half to three-quarters of an inch in length with strong heads are generally used. Very large engravings are screwed down where possible.

Type-High and Color Gauges.

In order to know that your blocking is type-high it is advisable to gauge it with an instrument made perfectly accurate to that height. Fig. 45 A represents the most popular style.

When blocking plates for color work it is very difficult to properly locate the plate on the blocks so they will register

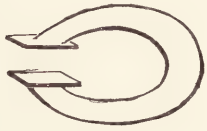


FIG. 45A



FIG. 45B

when printing. The gauge shown in Fig. 45 B. will be found useful for this purpose.

BLOW PIPES.

Engravings that are too large to be made in one piece are made in sections. When blocking, the joints must be soldered. This is best done with a blow-pipe and very small soldering copper.

The blow-pipe is connected with a gas supply and a foot-blower to furnish a strong draft of air, which greatly increases the heat. The small mouth blow-pipes are not suitable for this purpose on account of their inconvenience to apply the flame to the work.

GRAVERS.

All work needs more or less touching up with gravers after blocking, a set of nine or ten being required. A good selection is two round-edge, Nos. 50 and 57; three flat, Nos. 37, 40 and 44; two square, Nos. 0 and 9; two lozenge, Nos. 3 and 5; also one or two liners.

One eyeglass and stand, oil stove, pad and pad holder may also be included with the set of gravers.

KNURLS.

These are small round steel wheels with different designs on their edge, and mounted on a handle the same as are in use by harness makers. Knurls are used by engravers to dot out running lines by simply placing the face of the wheel on the line and with pressure roll the desired distance. The indenta-

tion on the wheel leaves its impression on the line, breaking it into dots. Besides the above-named articles a hammer, nail-set and punch, nippers and vise are necessary.

Proof Press.

The most desirable press for taking proofs from engraved plates is the "Franklin Press," called by some the "Washington," both being the same. They are made so that the pressure is applied by pulling a lever. The "Army Press" is preferred by some. It has a bed that runs under a heavy iron roller, the impression being regulated by raising or lowering the roller. This style of press is not so good for proof-making as the former.

Blocking of the Engravings.

The first thing to be done when blocking, if the plate contains any wide-open spaces between the lines, is to cut these deeper with the routing machine. The edges are also gone around. Great care must be exercised when operating the router, the knife should not be allowed to run into lines and cut away parts of the design.

Routing can be done before the last or deep edge is made, thereby cutting away the sharp shoulders left by the router knife, otherwise they must be removed with a graver. The plate is next trimmed close to the lines with the circular saw removing all unnecessary zinc.

Holes are now made, punched or drilled in the zinc for the admission of the nails, removing the elevations left from making the holes, also the edge left by the saw. Now place the engraving face down on the shoot-board, care being taken to have it clean. With hammer and a block, level the plate by lightly striking on the block, moving from one part of the plate to the other, until level and all kinks have been removed.

The blocking wood is next selected. Lay the engraving on it, mark off the sides and cut with a circular saw. The plate is now nailed to the block, the nails are driven in with a hammer part way, finishing is done with a nail punch. The nails should be driven in far enough to bring the plate in close con-

tact with the block, but do not hammer so hard as to cause the zinc to be dented. When properly nailed on, the block is squared up with the trimmer close to the edge of the line of the engraving. If the trimmer does not leave a smooth edge it should be smoothed with shoot-board and planes.

The mounted engraving is now measured with a type-high gauge at all points. If not equal in height, caused by the zinc not being in contact with the block, lay it on the shoot-board face up and with a smooth-face block gently hammer the raised portions in place.

A proof is now made from the engraving and carefully examined. If any parts have been filled up, or other defects are shown, remove them with the gravers. If the outrunning lines give too much impression, lay the engraving on the shoot-board and with a nail set, placed on one side of the line and then on the other near its extremity, gently hammer down, depressing it slightly into the wood base.

Cross-hatching is now done with a knurl, if needed.

Another proof is made and examined. If it prints up clean and sharp it is ready for delivery.

I wish to mention here that too much time and pains cannot be given to proof-making. If a good proof is shown your customers, very little trouble will be experienced in pleasing them. A faultless engraving may be rejected because the proper care and judgment have not been given it, whereas one not near so good would be taken without a word of fault because the proof was neat and clean. In other words it was all that the engraving could produce. A good, clean roller and heavy proof ink, with care and judgment, will soon teach you how to turn out properly made proofs.

Special Blocking.

Engravings that have solid blacks on certain portions can be made to print up stronger by cutting that part out on the proof and pasting it directly opposite on the reversed side of the zinc before nailing to the block.

Half-tone and others that have no places where nails can be driven are beveled on the edge with a beveling plane, which

gives sufficient space to drive nails in. There is still another way where the above cannot be utilized.

After the plate has been trimmed and the block cut to the proper size, holes about one-quarter of an inch in diameter are drilled through the block and countersunk on the bottom side, AA, Fig. 46. The zinc plate is now adjusted to its place on the block, and with an awl.



FIG. 46

Mark the places that correspond with the holes. The plate is removed and a drop of solder is fastened on the zinc at each place marked. Warm the plate again, put in place on the block, and clamp tightly with an iron clamp. Melt some solder in a ladle, making it rather hot; pour into the hole until filled and even to the bottom of the block.

In order to make the solder adhere to the zinc one or two drops of tinner's soldering acid (zinc dissolved in muriatic acid) is applied.

BLOCKING ENGRAVINGS IN SECTIONS.

Plates in sections are soldered together after trimming them until the parts match to perfection. This should be done before routing or trimming the outer edges. The two edges that go together are beveled from the bottom side, Fig. 47, and placed face up on the shoot-board.

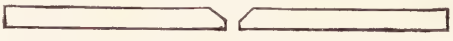


FIG. 47

The plates are held in position with heavy weights, and are now soldered together at one or two points that will not interfere with the engraving. The plate is now ready to be routed, trimmed, and finished, the same as if it was in one piece.

Failures Due to Printing on Zinc.

When a print on an albumen film washes entirely away when being developed, and the time of exposure has been correct, the albumen solution is decomposed and should be removed.

The ink smears in developing when it contains too much oil or varnish. Use heavier ink.

Albumen solution, if used directly after being made, dries in streaks or waves, when heat is used in drying.

The thicker the coating of albumen, the longer it takes to print. This is shown by the bottom of the plate, where the solution was poured off; being heavier it will at times wash away in developing, while the top or that part which is thinnest will develop with difficulty. When the coating is of uniform thickness all over the plate the best results are obtained.

If the plate does not develop evenly on all parts and the coating is uniform, it is caused by the negative not being in contact with the zinc, or the negative is weak at those points.

Round white spots, seen on the plate after development near the corner where the plate was drained, are caused by air-bubbles in the solution. Remedy: place the mouth of the funnel against the side of the bottle when filtering the solution, letting it run down its sides.

If the spots are more evenly distributed, it is caused by dust settling on the plate when drying.

The negative film adheres to the zinc and pulls off when the stripping collodion contains too much castor-oil, and the plate is placed in contact with it when too hot.

Failures Due to Etching.

If the acid eats through the ink coating on the lines, it is because the ink is not thick enough. Remedy: roll up immediately.

The gum solution should be fresh; if sour or mouldy it will not prevent the ink adhering to the whites.

The ink cracks and peals from the plate because heat was

applied to hasten the drying of the gum solution when gumming up. Always fan or let dry spontaneously. Never use heat. If the ink contains too much oil or is used in excess, the lines will become widened and ragged.

If the plate when etching oxidizes and will not return to its bright and clean color by brushing or washing under the tap, a few pinches of salt or powdered alum added to the etching bath will remedy this.

The ink takes on the whites when rolling up because the plate is not kept wet.

The plate becomes covered with numerous small specks called pimples, because the zinc is inferior or the development was not properly done, or the dragon's-blood was not entirely removed from the plate after powdering.

Insufficient etching during the first and second operations, and the zinc oxide not properly removed, will also cause pimples.

Pinholes in the negative cause similar results. The above-mentioned faults all have about the same appearance and effect. Therefore it will at times cause trouble to discover from what source they come. These pimples must be scratched off with the point of a knife-blade previous to etching.

When close lines appear almost like a solid, the first etching was not carried far enough or the plate was made too hot, when the ink spreads and runs together.

If the shoulders extend too far out beyond the lines, etching was not carried far enough.

The etching should, if possible, be carried until the acid eats close up to the lines.

CHAPTER X.

SWELLED GELATINE PROCESS OF PHOTO-ENGRAVING.

The swelled gelatine process, very popular in this country at one time, is at present but rarely employed, although there are still several of our large concerns who resort to it for the reproduction of fine woodcuts and lithographic prints, invariably with excellent results, especially in regard to their softness and detail.

One of the greatest objections to this method is the changing of the sensitiveness of the gelatine under the influence of weather—an evil but little understood generally, and requiring much patience and experience to overcome successfully.

Another objection is that it is not suitable for the general run of work, for instance, for newspaper illustration, which requires to be deep and open. If this class of work is produced by swelled gelatine, too much hand-work is necessary to make it profitable.

Much more machinery and apparatus is also necessary, which most persons embarking in the photo-engraving business are very apt to object to.

Description of Apparatus and Utensils Required—Drying Box.

For preparing the plates a suitable box is necessary. The sizes are made up according to the amount of work to be done; one suitable for a moderate amount of work is 4 x 5 and 2 feet. See Fig. 48. It is made with a double wall and lined with sawdust. At the lower left-hand corner a pipe enters, through which cold air is supplied from an ice chest and drawn in by a rapidly revolving fan, which allows an even continuous

draft to pass over the plates and out through the tube at the top. When the plates are dry they are stored away for future

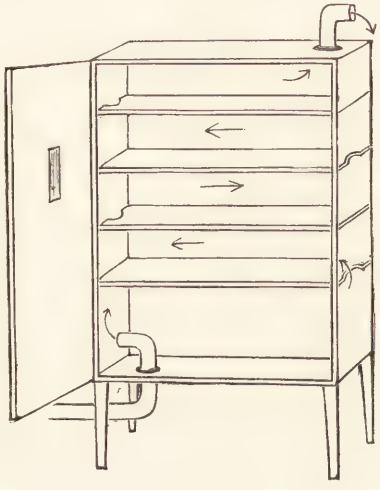


FIG. 48

use—in a light-tight cupboard, in the bottom of which a saucer containing chloride of calcium is placed.

SETTING SLAB.

A marble slab that is so arranged that it can be made perfectly level is laid on a bench in a suitable place in the dark-room. This slab must be used only for receiving the plates after they have been coated with gelatine.

CASTING SLAB AND SINK.

The best arrangement for casting upon, is a slate slab. It is kept well oiled, which keeps the plaster-of-paris from adhering to it. At the end of the slab the sink is placed. This consists of a half-barrel with the drain pipe running up within six inches of the top and made so as to unscrew at the bottom. This arrangement allows the tub to be kept full of clean water when in use and admits of being easily cleaned.

The Cooking Apparatus.

The cooking of gelatine must be done over a water bath, otherwise it is liable to become scorched, which would render it useless. For this purpose an ordinary carpenter's glue-pot is used, the bowl which is to receive the gelatine, however, must be porcelain-lined, otherwise it will be necessary to procure a china bowl that will fit in its place.

Stereotyping Furnace.

The style of this stereotyping arrangement is somewhat different from those used in making castings from papier maché. It consists of a large furnace with a square pot capable of holding three or four hundred pounds of metal. At one side—generally at the right—the crane stands. With this the pan that holds the plaster matrix is lowered into the metal to make the cast.

Casting Irons.

These irons are about fifteen inches long, one inch high and five-eighths of an inch thick. They should be planed level and kept well oiled.

PREPARATION OF CHEMICALS USED IN SWELLED GELATINE PROCESS.

Sensitizing Solution.

Consists of a saturated solution of bichromate of ammonium C. P. in water. The bichromate is put in a bottle and the desired amount of water added. It is well shaken at intervals for two or three days then allowed to settle until perfectly clear.

Swelled Gelatine.

Gelatine that I have found to give the best results consists of the following:

Nelson's photographic gelatine, No. 2.....¼ ounce
Coxe's Gelatine.....¼ "
Water..... 7 ounces

The gelatine is first weighed out and put in the bowl and the water added; it is then allowed to soak over-night. The gelatine is melted over the glue-pot, with constant stirring, and 80 minims of the sensitizing solution is then added; now raise the heat until by dipping a thermometer in the solution it registers 120 degrees F. maintain this heat for five minutes then remove and filter through fine muslin into a warm graduate. The solution must now be immediately flowed over the plates.

Plaster Separating Solution.

When a plaster cast is to be made from another plaster matrix, the two will adhere, making separation impossible, unless preventatives are employed. The matrix is therefore flowed with a solution of

Silicate of soda	3 ounces
Water	35 "

Hardening and Clearing Solution.

To prevent further swelling of the gelatine the following bath is used:

Water	36 ounces
Chrome alum	½ ounce
Citric acid	¼ "

OPERATING THE SWELLED GELATINE PROCESS.

Making the Gelatine Plates.

After selecting the requisite size of glass plates they are coated with gelatine. They must be perfectly clean and free from dust, and warm enough to allow the gelatine to flow easily. If you are coating 8x10 plates measure out one ounce of the warm gelatine solution and pour over the plate. To make it flow evenly plate must be held level and the gelatine distributed over the plate with a strip of clean white cardboard. When evenly distributed and free from air-bubbles lay it on the marble slab, which must be cold. Continue coating the other plates in the same manner. For 10x12 plates one ounce

and one-half should be used. The plates are allowed to remain on the slab in the dark-room until set, and are then removed to the drying box and placed in a perfectly level position. As soon as the plates have been properly arranged close the door and apply the draft; allow plates to remain in the box until all moisture has been driven out and they are perfectly dry. In very dry weather or climates the gelatine may crack and leave the plate, in such cases a few drops of glycerine should be added to the gelatine when cooking. Gelatine plates generally give the best results within three days after coating. When older the results are not satisfactory.

The plates are now ready for exposure. The negatives are made in the same manner, and should be of the same quality as for printing on zinc, only the films have not to be turned. The film is protected after intensifying, and while still wet with a solution of gum-arabic in water. Proceed to print by laying the negative face up in the printing frame; place on top of it the gelatine plate and apply the pressure with the screws. Remove the frame to the light. The time will vary from fifteen to twenty minutes in the sun to one or two hours in diffused light.

After exposure remove to the dark-room again and remove the plate from the frame and place face up in a tray and cover with clear, cool water. Those parts of the gelatine film not acted upon by light remain unchanged, and as soon as placed in water they absorb water and swell up. The other parts not protected by the negative and acted on by light have become insoluble and are not affected by the water; those parts therefore remain in the same condition.

While the gelatine is swelling it must be carefully watched. Keep the water in motion. By feeling on the edge of the image the gelatine will be found slightly raised. When about the height of a six-ply cardboard remove the plate and place in the hardening solution for not less than five minutes.

Making the Plaster Cast.

The hardening bath prevents the gelatine from further action of light or swelling. Remove the plate from the bath,

wash well under the tap and place face up on the casting stone.

Place two of the casting irons on top of it parallel with each other and about one inch from the image as shown in Fig. 49. Put some clean water in a bowl. What are known as "milk pans" are the best. Into the water put about a tablespoonful

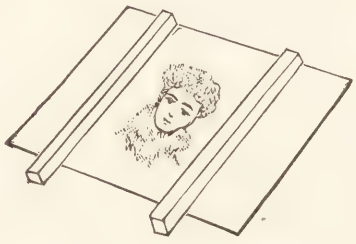


FIG. 49

of salt; when dissolved, add the plaster-of-paris by sifting through a flour sieve. Immediately mix with the hands squeezing out the lumps, and work into a homogeneous mass which should be about the consistency of cream.

The mixing of the plaster should be carried on as rapidly as possible to prevent it from setting. As soon as mixed, pour it on the gelatine plate and level off with a straight-edge, forcing the plaster over each edge of the plate; let it remain in this position until perfectly dry. The plaster-of-paris should be of the best kind, the dental, freshly calcined, being preferred. When the casting has become thoroughly set remove the casting irons, lift the casting and turn glass side up. With a knife cut the plaster away from the ends of the plate. Fig. 50.

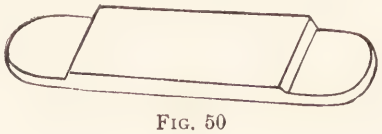


FIG. 50

The plate can now be easily separated from the plaster by catching hold of the plate with the forefingers and pressing down on the plaster with the thumbs. If the cast has been

successfully separated the two ends are broken off and with a knife trim the edges within half an inch of the picture, cutting it beveled.

The casting is now set aside until ready for use; it is then flowed several times with the separating solution and then washed well under a faucet. Lay face up on the casting stone and place the casting irons around it. Fig. 51.

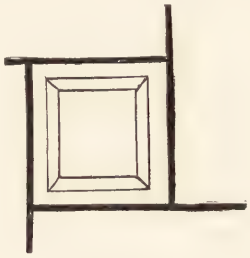


FIG. 51

Mix up plaster enough to more than fill the space inside the casting irons, the plaster being mixed the same as for the first casting. Pour in the plaster as slowly as possible; do not hold the bowl too high as the plaster is liable to catch air and form bubbles.

When the plaster has all been poured in work it around with the hand. Remove any bubbles that may have formed, scrape off level with the straight-edge, allow the plaster to set until perfectly dry. The two castings can then be easily separated by prying with a knife alternately at each of the four corners.

As many matrices as will fill the stereotype casting pan can be cast with one operation by arranging them close together, placing the irons around them.

FAILURE IN THE GELATINE PROCESS.

The gelatine does not swell evenly or uniformly because of being exposed to the action of light before being dry. Insufficient relief in swelling may be caused by inferior gelatine, improper drying, or by reflections from the glass in the printing frame. The latter defect may be remedied by placing a

piece of blackened paper or cardboard in the frame next to the gelatine plate and setting the printing frame in a box about three feet long with one end open, and painted black inside. This will keep outside light and prevent reflection. If after swelling a print with double outlines has resulted the position of frame has been changed during exposure. When the plates are exposed before being perfectly dry a ragged edge will be the result. If the swelling is carried too far the lines will be rounded.

Stereotyping.

While the metal is melting take the stereotype casting pan apart and lay it in the furnace on top of the metal. The lid first, then the float and lastly the pan, thus allowing each separate part to get hot. As the metal melts they can be easily arranged in the order wanted. As soon as the metal melts and the pan gets hot remove it, with a pair of blacksmith's tongs, and lay on the top of the casting block which is arranged convenient to the crane; the float is removed in a like manner and brushed clean with a whisk broom to remove any adhering metal, and placed in position in the pan. The plaster matrices are now arranged on the float face down, and close enough together to prevent shifting when submerged in the metal. If there are not casts enough to fill the pan scrap pieces of plaster are filled in to keep the matrices in place. When properly arranged the lid is removed, placed on the pan and screwed tight. Now swing the crane around and fit the prongs to the yoke of the pan and wedge tight. It is very necessary that the pan should be level, otherwise a cast which is thicker at one end than the other will be the result. Stir the metal up well with a circular motion allowing the metal to run until the dross collects in the centre. It is then removed with a skimmer and the operation repeated till no more separates. Try the metal for heat by inserting into it a strip of white writing paper; if it is scorched a light straw-color the metal is the proper temperature. Swing the crane around until over the furnace. Lower the pan into the metal, forcing it down just far enough to prevent the metal from running in.

Allow the pan to remain in this position until of the same temperature as the metal. Then test with paper as before. If the temperature is right the pan is gently forced down, allowing the metal to run into the pan in a small even stream until full. Then immediately force as far under the metal as it will go. A bubbling or boiling will soon begin. This is caused by the air and moisture being driven from the matrix. The pan must be submerged for several minutes after the bubbling ceases and care be taken to keep the metal at the proper temperature. After the bubbling has ceased allow the pan to rise gently to the surface, and with a broom brush the adhering dross from the top of the pan. Swing the crane around and lower into the cooling box and with a ladle pour metal into the pan until as full as it can be without running over. Pour water into the box until it just touches the pan; allow to remain in this condition for some time before more is added. When the metal and pan have become cool place on the block, remove the crane and yoke, and with a cold chisel and hammer remove the lid. Turn the pan upside down and allow its contents to drop on the block. It will have the appearance of a solid pig of lead. The float is easily removed by knocking off the four corners and sides. On the top of the plaster matrix a sheet of metal about as thick as card board is formed which is stripped off. The castings are now sawed apart when the plaster will fall off leaving the engraving bright and clean.

Finishing and Blocking Stereotypes.

The general principles for blocking stereotypes are the same as described under zinc etching. A greater amount of touching up and routing will be necessary, especially if the work is open. The back of the plate will have to be shaved level, which is done in a shaving machine constructed for this purpose.

Failure in Stereotyping.

If the cast is found to be hollow, it is caused by allowing the metal to run into the pan too fast or removing it before the air has ceased to escape. The plaster matrix breaks

because the metal is too hot, or it was not fitted closely enough to prevent floating around when submerged. If the casts are not sharp the metal was not hot enough or too little metal was in the pot, not enough to force the float up against the matrix. Inferior metal makes a rough, dull cast without sharpness. Pimples on the casting, appearing as if sand had been sprinkled over them, is caused by not removing all of the dross before casting.

CHAPTER XI.

LITHOTYPE ENGRAVING FOR COLOR WORK.

This process of engraving is used almost entirely for color work; the results obtained when properly operated closely resemble photographs. It is brought into use for the finest book illustrations, hangers, and general commercial work.

The additional appliances necessary to be added to a zinc etching plant are very small, and there is no reason why the method is not more extensively practiced.

The want of artistic sentiment, of color effect, and of how to combine colors properly, is the great obstacle many photo-engravers have to contend with. Without knowledge of color harmony the process can not be successfully practiced.

Preparation of the Graining Powder for Lithotype Plates.

The powder is prepared in different grades as to fineness. It is composed of

Rosin	8 ounces
Shellac	6 ounces
Gum asphaltum	2 ounces

Put the rosin in a stew-pan and melt, then add the shellac and heat, by stirring constantly, until melted and thoroughly incorporated with the rosin. Place the asphaltum in another pan and melt until perfectly smooth and no lumps appear. Then add the asphaltum to the rosin and shellac, pour in little at a time, with constant stirring, and mix well. When all the substances are in, heat the mixture until it begins to boil; remove from the fire and pour the mixture into a pail of clean, cool water. This will form it into a solid mass and make it brittle and easy to pulverize. As soon as hard remove from

the water and dry ; it is then ready to be pulverized, which is done in an iron mortar, and grinding as fine as possible.

The powder is then put in a muslin bag and shaken until the finest dust has been removed. What remains in the bag is then sifted through a fine sieve one hundred and fifty meshes to the inch, which makes the finest grade. For coarser powder a sieve with one hundred or a hundred and twenty meshes is used.

The Stopping-out Paint.

Is a thick solution of gum-arabic colored with any desired pigment such as Venetian red, or Prussian blue.

The Dusting Box

There are two different styles of dusting boxes in use, one is stationary with a bellows attached, the other is a box hung on supports so arranged that it can be made to revolve. The latter I will describe ; for general use it is best.

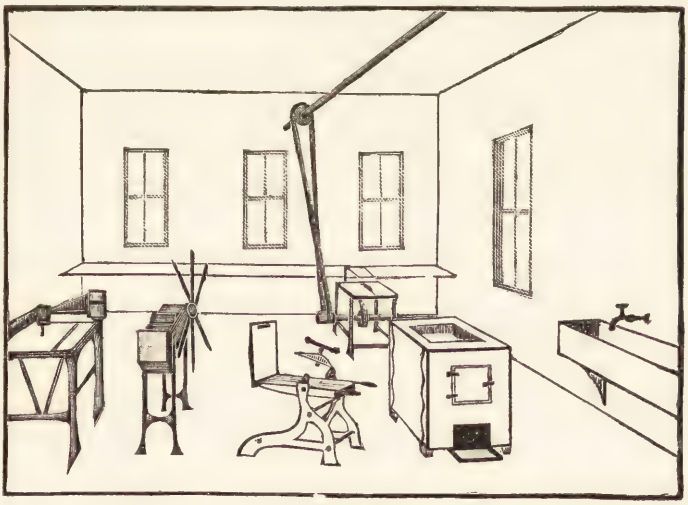


Fig. 52

A convenient size will be 18x24 inches and three feet high; a door 5 inches high and three inches from the bottom of the box is placed on one side; on the inside is placed a coarse wire

netting on a level with the bottom of the door upon which the plate is to be laid. A hole one inch in diameter is placed at one of the corners on the bottom, to allow the removal of

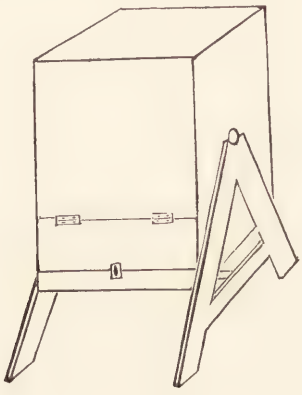


FIG. 53

the powder. This can be closed with a cork. The inside must be smoothly finished and varnished to prevent the powder from adhering to the sides. See Fig. 53.

MANNER OF OPERATING.

THE TRANSFER.

When doing color work it is necessary first of all to make, or have made, a wash drawing with the color and arrangement the same as the finished job is to be when printed. The drawing in the first plate is made and the etching is made from it. This is the key plate or the plate used as a guide to which the color plates must register. If the job does not have a straight line border around it, register marks in the drawing must be made at each of the four corners. They must be engraved on the plate the same as if it was part of the engraving. A proof on damp paper is now made, using instead of printing ink the stopping-out paint. While the paper is still damp a transfer is made on to zinc of the proper size and finely polished. The transfer can be made with any press capable of a heavy pressure, a sheet of india-rubber is placed next to the paper.

The proof is removed by lifting up one corner and gently stripping off; if it leaves the plate with difficulty, or parts of the paper adhere to the zinc, dampen the paper slightly and allow to stand a short time. It should then remove easily leaving the plate clean and the transfer sharp and distinct.

A color sketch is now taken and the color to be represented by this plate laid on. Those parts of the plate that are to remain white are painted over with stopping-out paint; the parts that are to be solid color are painted in with transfer ink thinned with oil of turpentine.

The plate is now ready to receive the first coat of powder. See that the grade of powder is in the box that will produce the tint desired. Then give the box a vigorous turn, allowing if to revolve several times; after stopping open the door and lay in the zinc plate face up. Close the door and allow it to remain in this position until it is judged enough powder has fallen on the plate to produce the desired color or tint. Knowing when to remove the plate at the proper time is of much value and can only be derived from experience. The plate is now removed without jarring, otherwise the powder will be disturbed and an uneven tint will be the result. If not enough powder has been deposited, the box is whirled again and the plate reinserted; if left in too long and an excess is on the plate the powder can be removed by carefully brushing with a camel's-hair brush. The plate is now slightly warmed, just enough to cause the powder to adhere to the plate; it is then allowed to get perfectly cool and those parts which are to represent in the finished cut, color or grade of tint, are covered with the stopping-out paint. The parts to be of heavier tints are not covered with the stopping-out paint until enough powder has been deposited. The stopping-out paint prevents further depositing of powder.

The paint is now allowed to dry. The box is whirled and the plate is again inserted; when sufficient powder has been deposited remove and heat as before. When cool those parts having reached the desired tint are now gone over with the paint, and so on until the desired gradation of tints to correspond with the color of the wash drawing is attained.

The second color plate is treated in like manner by making a transfer from the key plate and sketching in with pencil the outlines of the first color plate so as to guide in stopping out with paint those parts that are to be white.

After each plate has gone through the above process it is put in a tray of lukewarm water which will dissolve away the stopping-out paint and the powder that had deposited on it, leaving the plate with the image, representing the light and shade as produced by the stopping-out paint and the powder. All that now remains to be done is to etch the plates in the usual manner.

To aid the beginner in the practice of this beautiful process I represent a page in colors showing each plate printed separately and in combination.

After the plates have been etched and cleaned off the tints can be toned up and give a better finish by touching with

Bay salt	3 ounces
Sal ammoniac	1 ounce
Verdigris	1½ ounces

Grind up well together in a mortar with syrup of honey. For use apply with a brush to those parts that are to be toned or made lighter. The longer this composition is allowed to remain on the plate the lighter those parts will appear in the proof; if allowed to remain too long it will eat away the tint entirely. The plate is finally washed well in water and blocked.

CHAPTER XII.

PHOTOGRAPHING ON WOOD AND OTHER PROCESSES.

Photographing on wood for wood engravers will be found very profitable to the photo-engraver. It can be carried on with the general run of work and without much additional expense or trouble.

The following process will give satisfactory results if properly carried out. Take of

Gelatine (Nelson's)	124 grains
White soap	124 grains
Water	15 ounces

Soak the gelatine in the water for six hours and dissolve by heat in the water bath; add the soap gradually. Add one ounce of zinc white and mix well. The mixture is filtered through muslin, and then rubbed well into the surface of the block and allowed to dry. The film must be as thin and even as possible. When dry the following solution is applied with a flat camel's-hair brush.

Albumen	1 ounce
Chloride of ammonia	15 grains
Citric acid	7 grains
Water	1½ ounces

The albumen is beaten to a froth and allowed to settle. The chloride of ammonia and citric acid added, shaking well after each addition. When dry the film is sensitized by pouring on it the following solution:

Nitrate of silver	46 grains
Water	2 ounces

Pour off the excess in the solution and dry in the dark.

The printing is done as usual, using an ordinary frame or one constructed for the purpose * so as to allow the negative to swing back when the print is examined. Over-printing is not necessary with this process. The finished print is held about three minutes in a weak solution of salt and is washed and fixed for five or six minutes in hyposulphite of soda solution, 1 in 8. Wash well and dry.

Negatives to be printed from on wood should always be reversed, which is done by means of the prism, as heretofore described, or by copying through the plate.

Making Engravings in Sections.

Photo-engravings of several feet in length are frequently desired. To make them on one plate and by one operation, presents insurmountable difficulties and we resort to making the engraving in sections, and joining them afterwards.

In order to match the plates when blocking, the original drawing is divided into convenient parts by making a line through it as in Fig. 54. Draw the line if possible through parts which will match the easiest.

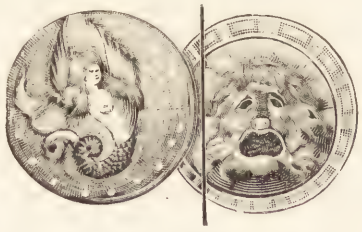


Fig. 54

A negative is now made of one section; the position of the drawing on the board is then changed and another negative made, and so on until completed, care being taken not to move the camera or copy-board after making the first negative. The glass upon which such negatives are made must be perfectly flat. After the negatives have been made ready to print from, they should be joined. When the negative has been made in

* The Scovill & Adams Company will furnish such frames.

three or four sections, it is best to transfer the stripped films upon a large plate glass and print from it after the individual pieces have been joined. To do this cut the negative film by laying a straight-edge on the plate and with a knife run through the center of the dividing line, and the remaining sides the same as usual. The film is now stripped on to another piece of glass and squeegeed down. The remaining negatives are treated in the same manner, watching carefully of the matches being faultless.

If the camera or copy-board has not been moved in the photographic operations, the films can be matched with little difficulty. The print on zinc is now made and the seams where the films are joined are touched up. After the etching is completed these parts can be finished with the graver so as to make it impossible to see the jointure. When the plate is too large to be worked in the manner just described each section is printed separately on a single sheet of zinc. The dividing lines for this mode must not be cut through the center as before stated, but should appear in the print with the lines of the engraving extending one-half an inch beyond it. When the plates have been etched and routed they are trimmed by cutting through the center of the dividing lines, best done with a shoot-board and plane. The plates, after being neatly trimmed and matched, are then tacked to the block. If it happens that the matching was not properly done the seams can be soldered and then touched up with the graver.

Blocking Plates for Color Work.

Color plates for photo-engraving are generally engraved by hand, or with a ruling machine, except when working the lithotype process. A proof is made with printers' ink upon a piece of damp paper. A transfer is then made from the proof on to a stereotype metal plate. The parts not desired to show in the print are then cut away and the necessary tinting made with graver and ruling machine.

The register marks, as described under lithotype engraving, should also be on the key plate. Each succeeding plate representing a color is treated in the same manner until completed.

When blocking the plates they are nailed on the base as usual, but great care must be exercised in trimming or squaring up. Trim so that the register marks are cut half away on each plate represented leaving just enough space to make a distinct print. The color plate to be printed from first, is locked up in a chase, and a few proofs made; then prove the next one that is to be used, and so on until each single plate has been proved.

Combined printing, one color upon the other, until each color effect is shown, follows. If the plates have been properly blocked and each succeeding plate prints exactly upon the same place, occupied by the first print, the register marks should all be on top of each other, appearing when completed as if made by one impression. If they do not register, they must be re-measured with a finisher blocking gauge and corrected

Making Engravings with White Lines on Black Backgrounds.

It is often the case that an engraving with white lines and a black background is to be made from an ordinary line engraving or type form. The manner of doing this is very simple. All that is necessary to do is to make a good proof from the engraved plate upon tracing paper, sheet gelatine or celluloid, and before the ink has dried, dust well with bronze powder. The resulting proof is now suitable for making a print upon zinc.

The above process can be used only when the resulting cut is to be the same size as the original; if to be made larger or smaller, a negative is first made from the drawing in the usual manner, and from it a positive print on a gelatine dry plate, printed on zinc and etched.

The Photometer.

This instrument will be found very useful for ascertaining the proper exposure when printing on inflexible material that cannot be examined during exposure. It consists of a scale,

printed or drawn on tracing paper, running from No. 1 to 20. See Fig. 55. Cut a number of strips the same width as the scale.



FIG. 55

Lay one strip commencing at the dividing line between 1 and 2 and run it to the end, then another strip so as to cover No. 3, and so on until each number has been in turn covered with an additional strip of the paper. This makes No. 1 consist of one thickness of paper, No. 2, two thicknesses, and No. 3 three layers, etc.

By using the scale as you would a negative, making a print on blue paper, it will take twice as long to print through part No. 2 as through No. 1, and twenty times longer through No. 20. If a print was made and the exposure continued long enough to allow the light to act on the paper under No. 20, by examining the print, it will appear in graduated tints, No. 1 being very dark, No. 2 somewhat lighter, and so on, until No. 20 is reached which will just show a very pale color. To use this instrument it will first be necessary to make a number of experiments with any sensitizing solutions you choose in order to ascertain the correct time of exposure. Select a good, clear negative and make a print the same as usual, exposing the photometer also at the same time.

When it is judged the exposure has gone far enough, remove the printing frame and photometer to the dark-room. Remove the zinc from the frame, roll up and develop. If the resulting print is perfect in every respect as to exposure, examine the photometer and ascertain the highest number that can be distinguished.

When making a print from a negative, in order to ascertain the proper length of time, the plate exposed in the photometer should be examined occasionally. When the number is visible that was distinguished in the trial print, the frame should be taken to the dark-room, the plate removed, rolled up and developed. If negative and sensitizer was the same quality and

property as those used in the trial exposure, you can depend on it that the print will come out all right.

All that is necessary for successfully printing by the aid of the photometer is to use paper of uniform sensitiveness, and the sensitizing solution made after the same formula.

Chalk Plates.

The main feature of this process is cheapness, simplicity and rapidity of production. For cheap work without much detail, for newspaper, and other rough printing it is very useful.

To make chalk plates first secure several sheets of black fourteen-ply cardboard, and several sheets of mica with a smooth surface. The cardboard is then cut to the desired size, and the mica to match. They are then pasted together with silicate of potash, and cut under pressure in a copying press, slightly heated and allowed to remain until dry.

To coat the plates thus prepared take

Egg albumen	120 grains
Water	6 ounces
Ammonia liq. conc	¼ ounce
Glycerine	7 drops

Dissolve the albumen in the water and add the glycerine, then the ammonia, shake well and filter. To the above, mix in a mortar and to a thick paste.

English chalk precipitated	3 ounces
French "	1 ounce

When mixed to the proper consistency, spread the mass upon one of the prepared plates by means of a trowel to the thickness of about one quarter of an inch.

The plate thus prepared is then placed on a hot oven or stove until dry. If the temperature is too high the composition will be forced from the plate by steam formed.

After the plate has become thoroughly dry it is removed to a cool place and the hard crust formed on top during drying is removed with a knife. Under this crust the composition will be found to be soft and can be brushed away very easily.

But that part immediately next to the plate should adhere rather firm.

The composition is now made level by scraping with a straight-edge. It is then ready to be engraved, which is accomplished by lightly making your sketch on the surface of the composition, afterward scraping through it with a sharp pointed tool to the mica. This should leave a sharp line, revealing the black cardboard, which has about the same appearance as a drawing in pen-and-ink on white cardboard.

All that now remains to complete the cut is to make the stereotype, which is done exactly the same as from *papier maché*. After routing away the wide open spaces it is ready to be printed from.

Transferring.

Paper known as gelatine transfer paper is used by all processes where photographic productions have any connection with transferring.

The paper is prepared by floating Bank Post paper on a warm solution of gelatine. When dry, a coating of albumen is spread on and allowed to dry.

As this paper can be bought at any dealer's in lithographers' supplies, much better and cheaper than it is possible to make, I will not describe its manufacture.

These gelatine-coated sheets are now made sensitive to light by applying to their surface

Bichromate of ammonia	¾ ounce
[or bichromate of potash 1 ounce.]	
Water	16 ounces
Alcohol	4 ounces
Aqua ammonia	1 ounce

In winter it is better to use bichromate of ammonia and in summer ¾ ounces bichromate of potash is sufficiently strong.

After filtering pour the above solution into a suitable tray, which must be perfectly clean. Take one of the prepared sheets, holding it by two opposite corners, and draw it face up (gelatine side up) through the solution twice, very slowly. Now hold it over the tray for a few minutes, and allow the

surplus solution to drip off, then lay it face down on a sheet of polished plate glass which was previously gone over with vaseline and wiped well with a clean rag until apparently no more of it remains.

The wet sheet on the glass is now squeegeed and as much moisture removed as is possible, care being taken to remove any air that may be under the sheet by pressing them to the edge.

The plate is then set aside in a well ventilated dark-room to dry. Heat must not be used under any circumstance. The paper should dry in about five hours, according to temperature. When removed from the glass it is ready for use. The sheet will easily detach by loosening the edge and by slightly pulling.

The surface of the paper will be as smooth as the glass itself, if carried through as explained.

Sensitized paper thus prepared is kept in a book and is good for four or five days only. It should be protected from all moisture and changes of temperature.

The Exposure

Is made about the same as when printing on zinc, instead of using the printing frame for zinc printing, photographers' deep frames with strong springs at the back are used.

The negative is first placed face up in the frame then the sensitized paper face down, on this put several thicknesses of soft paper, then the lid, press down with the springs, and expose to light.

The time necessary to complete the exposure will vary from two or three minutes in direct sun, or ten to twenty minutes in diffused light.

The progress of the print is watched by removing it to the dark-room, opening one end of the back and raising up the print. If it is of a strong dark brown, and all detail well defined, the exposure is completed. Remove the print and lay on a smooth board and fasten the four corners with thumb-tacks and proceed to roll it up, using the ink described in a previous chapter, and the lithographic roller.

Spread a small amount of the ink on a slab and add enough turpentine to make it as thin as syrup.

Distribute well on slab and roller and pass over the print. Be careful not to put on too much, just enough to allow the yellow film to be visible through the ink. It makes a very even tint.

Developing.

The inked-up print is now laid in a dark place for a short time to allow the turpentine of the ink to evaporate as much as is possible.

It is then immersed in a tray containing clean, cool water, where it should remain for at least twenty minutes. Keep well covered with water by placing a wet sponge on it to make it sink. The wet sheet is then removed and placed on a sheet of glass, face up, and with a tuft of filtering cotton, gone over the print in a circular motion without too much pressure. This will remove the ink from those parts of the print protected from the action of light by the negative. Continue washing until all of the ink not forming the image is removed.

As soon as developed, wash well in running water and place for three minutes in a solution of

Alum	1 ounce
Water	40 ounces

This hardens the gelatine and prevents it from taking up any more water.

After taking the print from the alum bath, wash again and remove the surplus water by laying between sheets of absorbent paper. The print can now be allowed to dry for future use.

Take the dried print and place it in a book between sheets of moistened blotting paper, long enough to make it slightly damp and limped, or until the gelatine commences to get sticky.

The print is then laid face down on the polished zinc plate; on top of the print place another sheet of damp paper, and on that a sheet of dry paper, and heavy cardboard; run through the transfer press, giving it at first a very light pressure, and

increasing it a little each time it is run through. Experience is necessary to know the amount of pressure to give and how many times to run through the press.

The transfer can be examined by raising up the corner. When found to be correct, remove the backing sheets, and moisten the print slightly on the back. Replace the backing sheets, and run through the press once more. Then remove the backing sheets, moisten the print, and carefully pull it from the zinc.

The plate is now washed well in running water, and then dried by blotting with a damp chamois skin. Examine the transfer, and if thought that it is strong enough to be etched, proceed by powdering up and heating. If on the other hand the transfer is weak, it must be gummed up and inked as described in zinc etching.

Copper-Plating Zinc Without a Battery.

It is well known to all persons who are at all familiar with zinc etchings, that if they are allowed to stand for any length of time, have been washed with strong lye water by the printer, or stored away in damp vaults, the plates soon become oxidized and gradually decay. When a plate in that condition is put in the printing press, under a strong pressure the finer lines and dots will yield and be crushed away, thus leaving the etching entirely worthless.

To avoid the above faults plates must be protected in some manner. The best way to do this is to coat them with a thin hard coat of copper, by immersing for a moment in a bath composed of

Chloride of copper	1 ounce
Water	"

dissolve and add to it

Ammonia liq. conc	1½ ounces
Water	15 "

This makes a beautiful blue solution; add to it a saturated solution of cyanide of potassium till the blue color is about gone.

In order to get the best results from this process, it is necessary that the plate should be free from all grease or ink. The cleaner it is the better.

Plates that have been used must first be scrubbed with a brush and lye water and lastly with diluted ammonia water.

Etching Half-tones on Copper.

The best half-tone work made in this country is etched on copper, and the printing done with bitumen.

When a half-tone print is made with the albumen sensitized solution, they are nearly always ruined during development, by streaks produced by rubbing with cotton, when the ink is being washed off. As the lines and dots are so fine and close together, the least variation in the amount of pressure, or rubbing harder in one place than another, streaks in the direction rubbed are sure to occur, especially in large even tints, such as skies, etc.

This is impossible when printing with bitumen, as it is entirely a chemical operation, and does not need rubbing or touching the image at all.

A piece of copper of suitable size, free from holes or flaws of any kind is selected, and the highly buffed surface sensitized with bitumen solution.

It is exposed and developed as described under its proper heading.

Instead of using nitric acid for etching on copper, we use a saturated solution of perchloride of iron; it etches the copper faster and without danger of eating away the print which would occur if acid were used.

Put the usual amount of clear water in the etching tub and add to it one ounce of the saturated solution of perchloride of iron. When well mixed with the water, put in your plate and watch closely. If enough perchloride of iron has not been added to oxidize the plate, remove it and add one half-ounce more and try again and keep on adding the iron solution until it attacks the copper, care being taken not to add too much, otherwise dots and all finer details will be etched away leaving the plate worthless. The solution in the etching tub should

be kept at such a concentration that it is just strong enough to etch the copper and no more.

If possible the plate should be completed with one etch, easily to be done by allowing the process to take its own time.

If the plate is found too weak it is left in the bath until it is deep enough to stand printing from, when it must be removed, dried and inked up as described under zinc etching. The ink will not take hold of the bitumen print as readily as if it were made in ink, but with patience and continued rolling it will soon present an even coat of ink. The plate is now washed lightly with a damp sponge, dried, powdered once, and then the etching is continued.

Intensifying Half-Tone Negatives.

Perhaps the best of all known methods of intensifying negatives for half-tone work is the Copper Sulphate process. By it negatives can be kept entirely under control and almost any intensity can be obtained.

After the negative is fixed and washed well it is placed in a tray containing

Sulphate of copper	1 ounce
Bromide potassium	½ ounce
Water	10 ounces

The tray is kept rocking until the negative has changed to a heavy cream-color; it is now placed under a tap of running water and washed until the color has changed to that of dirty brown; this will take from ten to fifteen minutes. The negative, if very strong, is next blackened by pouring off and on from a bottle

Nitrate of silver	25 grains
Citric acid	8 grains
Water	2 ounces

until the film is an even black color and has penetrated through the film; that is to say, should be black when viewed from either side of the negative. The plate is

then washed again thoroughly and cleared by pouring off and on several times

Nitric acid	1 drachm
Water	4 ounces

After this application and washing again the plate is set on the rack to dry. If after the bleaching with copper solution the negative is found not to be as strong as desirable, instead of intensifying with silver, use

Hydrosulphate of ammonia	1 ounce
Water	5 ounces

This solution has a much stronger effect than silver and must be handled with much care. The chemical must at all times be of the best quality and fresh, and only as much be taken from the stock bottle as is wanted for one application.

The plate is now washed and cleared with acid clearing solution, which removes all green fog, leaving the plate perfectly clear, providing the preceding operations have been carried out correctly.

Very weak negatives can be re-intensified by repeating this operation, if necessary, by first bleaching with copper, then using silver or hydrosulphate of ammonia solutions. If the negative is not strong as desired, and after intensification becomes necessary, place again in the copper solution until bleached and intensify again. If satisfactory, the negative is dried and stripped in the usual manner.

CHAPTER XIII.

TONE ETCHING ON COPPER.

Two articles reprinted from THE PHOTOGRAM.

Last year we published an article entitled, "Photo-Etching on Copper," quoted from *The Artist Printer.* This attracted a considerable amount of attention, and we have received, and are still receiving, many letters upon the subject. We have therefore decided to republish the gist of the matter, together with some additional information since obtained by our own personal experiments.

"For a long time it was considered that the fine half-tone blocks obtained on copper by one or two Eastern firms were due to their use of bitumen as a sensitive coating, and although such may have been the case in the earlier stages, it soon became apparent that something else was being used, especially when the original blocks were examined and an enamel-like coating, indestructible in printing, was found to remain on the copper; then came the puzzle, What is it?

"When we began our own experiments we had in view the necessity for some sensitive medium which would be easy of solution, flow nicely, print quickly, develop readily, and, above all, stand the etching fluid well.

"So far the field of research was limited. It was of comparatively little use looking for anything but ammonium bichromate as a sensitizer. It is a simple and, at the same time, a stable compound. The great trouble was in finding

something like gum which would carry the bichromate, and, at the same time, be rendered insoluble by the action of the light upon it. This medium must also have the property of being freely soluble in cold water.

"A variety of fine glues were tested, but the difficulty of getting them absolutely free from acids or alkalies rendered them unfit (if not on first mixing, still at a very early stage) for use.

"One day, in course of conversation with a gentleman engaged in the glue business, he gave us a sample of fish glue which we took home for test, and at almost the first trial we were thoroughly pleased with the prospects.

"In the first place, it dissolved readily in cold water, did not become coagulated by the action of the bichromate (at least, not at first), and it gave an excellent print with a short exposure. But we could not develop it, it would not wash out clean; but, nevertheless, we developed as well as we could, burned it in and put in the acid, or rather iron, and allowed it to remain in it for twenty-four hours without the slightest harm, and we then knew that if we could get over the difficulty of development there could not be a better coating. We found the cause of the trouble lay in the acid used in curing the fish glue, and we tried several brands with like success, but at last we got a brand which was as near neutral to test paper as possible, and on this we based all our further experiments, the success of which may be understood when we say that nine-tenths of the photo-engravers who do copper-etching are using our process or a modification of it.

"To thoroughly understand the whole matter of printing solutions, it must be remembered that there is no hard-and-fast rule as to the amount of bichromate to be used so long as it is not in such excess as to crystallize, and that the medium must be of an elastic nature to enable it to stand the heating and burning-in process.

"Our formula for use was as follows:—

"Fish Glue	2 ounces
Eggs (whites)	2 ounces
Water	4 ounces
Ammon. Bichrom.	120 grains

"This was found to give excellent results, both as regards speed of printing, ease of development, and power of standing the etching solution.

"The instructions stand thus: Beat up the whites of two eggs in two ounces of water, and when well beaten up add two ounces of fish glue; mix well, and having already dissolved the 120 grains of bichromate in the remaining two ounces of water, add it gradually to the egg mixture, stirring all the time. Let stand for an hour or so, then filter well, preferably through a felt filter, such as is used for filtering syrups, when it is ready for use. In regard to the felt filter, it must be well washed after use, not allowed to get hard; in fact, it had better be kept soaking in clean water all the time.

"The copper to be in proper condition should be polished and, immediately before coating, should be rubbed over with a tuft of wet cotton dipped in zinc white. This takes away the natural greasiness of the copper, and enables you to flow the solution evenly.

"As soon as printed, take the copper plate and put it into a tray full of water, and let it soak for a couple of minutes; then wash well under the tap; do not be afraid of spoiling it, for it will stand good hard usage; now flow over with alcohol, and allow to dry.

"Have your stove all ready and burn in. You cannot very well burn too much, as it will stand up to 750° F. without danger, but burn in until you get a nice brown colour. This colour depends not so much on the time of burning as the thickness of film; if the film is a little thin, you cannot burn it past a dirty brown. Do not get anxious about its slowness in changing colour; it will do that all in good time.

"When thoroughly burnt you must allow to cool gradually;

no cold slab must be used, as the sudden contraction might tend to split the film.

"When cool you can etch in perchloride of iron, either a diluted solution or a saturated solution, preferably the latter, as it gives a better opportunity of watching the effect; brushing is only to be done occasionally and very gently; no rocking is necessary.

"When sufficient depth is reached, which should be in from ten to twenty minutes, wash well under the tap and dry; take a proof, and if found of insufficient depth, put it into the etching bath again, and so on until satisfied.

"There are many ways in which this printing solution can be modified, but the above gives excellent results, and personal experiment from it as a base will give a power in printing for colour and effect which cannot be had with the older process."

At the outset those wishing to work the process as above met with considerable difficulty in obtaining the "fish glue." This article is sold under the name of "Le Page's Liquid Glue," and is manufactured by the Russia Cement Co., Gloucester, Mass., U.S.A. The British agents are Richards and Ward, 46, Holborn Viaduct, London. There are various kinds of glue supplied by this firm, the proper brand being No. 20 F. Ordinarily this is only supplied in one-gallon cans and upwards, but we have arranged with the firm to supply it for the use of photographers in one-pint tins. It is a thick, viscous mass, resembling honey, and will keep for any length of time if protected from the air. Weigh out the quantity required in a small jar. Place the tin of glue in a basin of hot water, as, when warm, it can be more readily poured out. One difficulty of the process is obtaining the sensitive solution clear and free from sediment. Even after it is allowed to stand for a couple of days there still remains a large amount of insoluble matter in suspension which must be got rid of. Filtration must be resorted to after allowing the liquid to stand. The solution is extremely

viscous, and only those who have had to filter it know how tedious the operation is. A jacketed funnel by which to keep the liquid warm while filtering is better than the method described in the original article. The filtering medium should be a little cotton or glass wool, preferably the latter. The temperature of the water in the jacket should not exceed 100° F.

The above method, however, is somewhat slow at the best, and we hope in a future issue to describe a plan to expedite matters, at the same time giving further practical information *re* the process.

In our last issue we promised to give a method by which the fish glue used in the above process could be freed from suspended matter. It will be well to clarify a fair quantity, so that it is ready for use when required. To do this, take

Fish Glue	8 ounces
Water	8 ounces
Albumen (white of egg)	8 ounces

The water is added to the glue, stirring well to ensure thorough mixture; then the albumen is mixed in; again carefully stirring. This mixture is placed in a pan (preferably an enamelled one) capable of holding twice the amount, and heated to boiling point; stir well the whole time, and boil for one minute. Now stretch over a large funnel or a jug a couple of thicknesses of fine muslin, and pour a portion of the liquid into this. The clarified glue will run through, leaving the coagulated albumen (which contains the bulk of the previously suspended matter) on the muslin. When the whole of the liquid has run through, bottle for future use. Wash the muslin for another time. To make up the sensitive solution take quantities as follows:—

Fish Glue (clarified)	4 ounces
Albumen	2 ounces
Water	2 ounces
*Ammon. Bichromate	120 grains

*Many workers prefer to use half the amount of bichromate, as with the full 120 grains there is a liability for the bichromate to crystallize.

Others have stated that in clarifying the glue there is considerable loss. This is due to insufficient boiling, the time given being found with further experiment, to be somewhat longer than originally stated, and it is well to prolong the operation until the scummy matter rises to the surface. If sufficient boiling is given there is no difficulty in getting the liquid nearly free from suspended matter. If this is done and sufficient time is allowed for the after filtration, there is really little waste. A very good way of filtering is by means of a conical flannel bag. When the liquid has run through the bag is squeezed. Practically the whole of the scummy mass inside the bag can be freed from the glue. For those who do not care to clarify the glue we may mention that Richards and Ward supply the article ready prepared.

Take a wide-mouthed, corked bottle, place in it a few pieces of clean glass, broken small (say, 2 oz.), weigh out the glue in a small jar. Pour into the bottle, and add the albumen. Dissolve the ammonium bichromate in the water, and then add to the mixture. Now shake until the whole is well frothed, and then allow to stand away from daylight for twelve hours. Then carefully filter (taking care not to disturb the scum) and the solution is ready for use.

The fish-glue process, described above and in our last issue, is undoubtedly *the* process for half-tone work. Within the past year it has been taken up by many of the leading British workers. Some of them, like the original American workers of the process, leave the resist on the block, where it forms an admirable printing surface. Others, as, for instance, Waterlow and Sons, Ltd., usually remove the resist and print from the zinc or copper.

The great difficulty found by those who leave the resist to print from is in the fact that printers *will* clean their blocks with a strong pearl-ash lye which removes not only the ink but also the resist—with disastrous results if the block has been but lightly etched. Many printers have

stocks of these blocks, from which they are probably not aware that they have removed the printing surface, and which will give infinite trouble when they come to be used in future jobs. The ink can be cleaned from these fish-glue blocks with turpentine, and, if very stiff and dried in, brushing with not too hard a brush. Zincographers using the process should point out this fact to their customers.

It is, of course, very desirable that a method of rendering the fish-glue impervious to caustic lye, and therefore capable of being washed with the type, should be found. In large formes it is difficult to lift out the blocks before washing the type; and as washing is usually in the hands of the P.D. or the careless apprentice, it is useless to suggest that proper care will keep the lye on the type and away from the blocks, so that the blocks can be washed with turpentine separately.

TONE ETCHING ON ZINC.

By an American Process Worker.

The chief difficulty in half-tone enamel process on zinc is that the enamel usually requires too high a degree of heat to burn it in sufficiently to prevent lifting in the acid bath. An enamel made by the formula given here will be found to overcome the disadvantage.

Fish Glue	2 ounces
Liq. Ammonia	½ ounce
White of Egg	1 ounce
Water	2 ounces
Ammonium Bichromate	60 grains
Chromic Acid	10 grains

If clarified glue, as made according to formula in *The Photogram* of February, 1894, is used, take double the amount of glue and omit the water.

Beat the white of egg to a froth with one ounce of water; to this add the liquid ammonia, then add the glue. In the

remaining water, dissolve the bichromate and chromic acid and add to the egg and glue; mix thoroughly and filter for use. This enamel is very sensitive, and burns in easily, even on soft zinc. Now the main thing in this process is the acid for the etch. Don't use ordinary nitric acid. The formula with which I have been most successful in obtaining uniform results I make as follows:—

Sulphuric Acid	6 ounces
Potassium Nitrate	2 ounces
Water	20 ounces

Dissolve the potassium nitrate in the water and then gradually add the acid.

For etching I use this diluted with water to the point where no bubbling (or gas formation) occurs, and I do not rock the plate while etching. I have, with this enamel and acid, successfully produced perfect half-tones on soft zinc nearly, if not quite, equal to best of copper.

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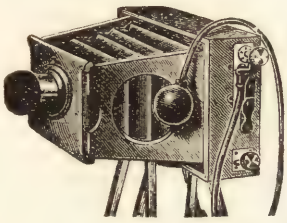
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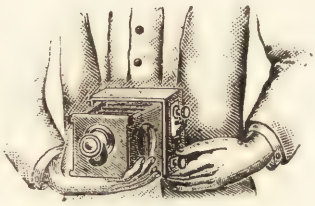
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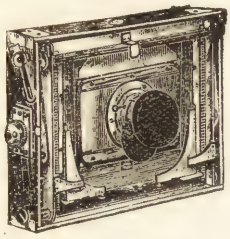


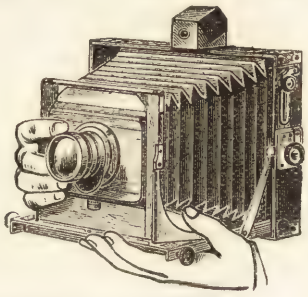


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